May 16, 1911.

MAY 16 1911
PUBLIC LIBRARY
OF DETROIT.

POWER

Issued Weekly by the Hill Publishing Company, 505 Pearl St., New York

Price 5 Cents, $2.00 per Year

Contents 781. Advertising Index 69

DUXBAK BELTING TRADE MARK

DUXBAK BELTING TRADE MARK

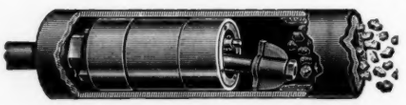
SPARE BELTS

should be as good or better than the ones they replace temporarily. Why not use Duxbak Belting for spare belts? Duxbak Belts are stronger and better pullers for their width than other kinds of belting. They can substitute for a wider belt without danger of injury to their fibre or loss of time. This spare belt subject should have more attention by the progressive manufacturer—it's important. Send for type talks on Duxbak.

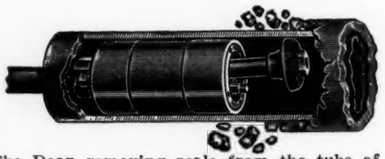
Chas. A. Schieren Company
ESTABLISHED 1868.

TANNERS
BELT MANUFACTURERS

NEW YORK, 69 Ckt St.
CHICAGO, 128 W. Kinzie St.
BOSTON, 641-643 Atlantic Ave., Opp. South Station.
PHILADELPHIA, 226 South 3d St.
PITTSBURG, 205 Wood St.
DENVER, 1752 Arapahoe St.
BROOKLYN, N. Y., Cor. 13th St. and 3d Ave.
HAMBURG, GERMANY, Auf dem Sande 1.
OAK LEATHER TANNERIES, Bristol, Tenn.



The Dean removing scale from the tube of a water tube boiler.



The Dean removing scale from the tube of a return tubular boiler.

Don't Guess About Scale

Of course, you believe in having clean tubes—believe that boilers with clean tubes are safer to operate, give more steam, use less fuel and cause less trouble all around.

But ARE your tubes clean?

Better make sure, for you don't want to risk running up big coal bills, or burning out your tubes.

And you can find out for sure with a

Dean Boiler Tube Cleaner

Many an engineer has been most positive in his declarations that his tubes were clean until he tried the Dean.

Now, when you can get a Dean for free trial in one boiler without incurring any obligation other than to return it at our expense if you don't want to keep it—

Is there any reason why you should simply *guess* your tubes are clean?

Better send for a Dean today—and find out.

The Wm. B. Pierce Co.

Jewett Building Buffalo, N. Y.

Chicago Office: 801 Steinway Building

Excess Air The Cause Of Fuel Waste

Keep the furnace doors open, give excess air full play, and see whether you can keep up steam.

It makes little difference how or where the air gets in—whether through the open furnace door, "rat holes" in the fire, or cracks in the setting.

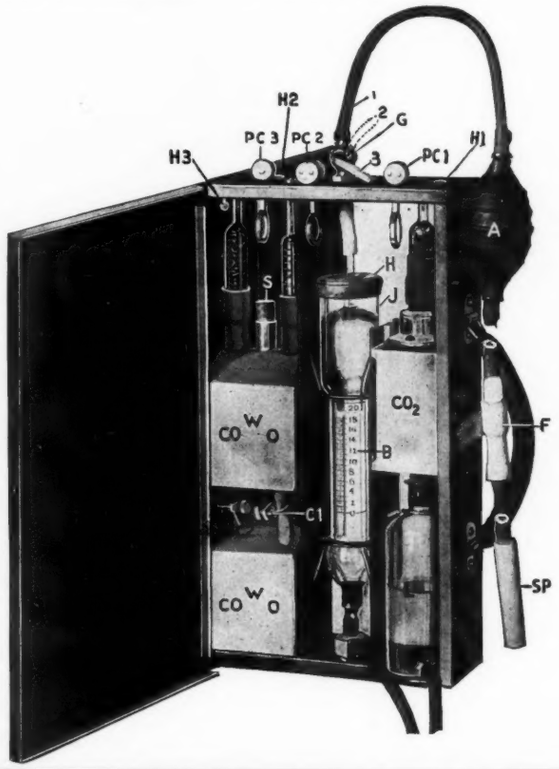
It will chill down the gases with which you are trying to heat the boiler and you will have to burn more coal and provide more heat to take the place of that stolen by the excess air.

Our *Gas Analysis Instrument* will tell you how much excess air there is in your furnace.

With it you can determine how to fire, how to regulate your draft, how to cut down fuel losses.

And you don't have to be a technical man in order to operate it, either.

Any man who can use a leveling bottle and read a scale can make a perfectly correct analysis of the flue gases with our instrument. *Write for catalogue.*



POWER

NEW YORK, MAY 16, 1911

MANUFACTURING in the New England States dates back to the landing of the Pilgrims at Plymouth, Mass. It was not always carried on by means of the steam boiler and engine. The early looms and spinning wheels were deftly operated by the dexterous fingers of the settler's wife and daughters.

Whenever the arms tired with the wielding of the "wheelboy" the speed of the spinning wheel was reduced and the output of home-spun yarn fell below the average.

Conditions have changed since the days of the spinning wheel. Today more cotton and wool are spun in one hour in the mills of New England than could have been spun in years by all the settlers' wives put together.

But the relation of speed and output remains the same. If the engineer today allows the steam pressure to drop and the speed of the engine is reduced but one-half turn per minute, the speed of the spindles on the spinning machine in the factory is reduced several revolutions, the threads of yarn are not twisted as rapidly and the output of the mill falls below its rating.

This is one of the losses which is hidden by the turning of the wheels. To all appearances the speed is as it should be, but the loss of that one-half turn of the engine flywheel is multiplied a good many times by the thousands of spindles in the mill.

And the engineer is the one man to blame. He can prevent this loss if he will. There are some mighty good engineers in the New England States in charge of cotton- and woolen-mill steam plants, but it is a certainty that all of them do not keep their engines right up to the maximum speed all of the time.

It is evident that the engineer who does keep his engine up to speed is the man who is giving his employer the better service.

Of course, loss of speed reverts back to the boiler room, but it is the business of the engineer to run the boiler room. If he does not get 100 pounds of steam it is his own fault.

Thousands of dollars are never earned in manufacturing plants because the speed has been below that required to give normal capacity.

The loss of one-half turn of the flywheel per minute is seemingly a small matter, but it costs money. The loss is seldom traced to the engineer, but if he knows of the loss and fails to improve conditions, he is missing a great opportunity to make a saving for the firm.

In many cases it means just as much as keeping the cost of fuel down to the lowest possible amount.

By the way, how much does the speed of your engine affect the output of your finished product?

New Power Plant of Dennison Mfg. Co.

By W. O. Rogers

This modern installation takes the place of two old plants. Noncondensing Corliss engines, coupled to direct-current generators, are installed, and the exhaust steam is used for manufacturing purposes. Four Wickes boilers fitted with Dutch-oven furnaces and mechanical stokers supply the steam.

The Dennison Manufacturing Company, South Framingham, Mass., has just completed a new, modern power plant. The building, 110 feet long by 110 feet wide, is constructed of brick and is large, light and roomy.

Engine Room

In the engine room, Fig. 1, are two Hewes & Phillips twin engines, each cylinder being 14x33 inches and capable of producing 225 horsepower or 450 horsepower for each engine. There is also one single unit of 225 horsepower, having a cylinder of the same size as the twin engines. Each engine is direct coupled to a Crocker-Wheeler direct-current generator. Each twin engine drives a 350-kilowatt generator, which delivers a voltage of 240 to the line, at 150 revolutions per minute. The single engine is direct coupled to a 150-kilowatt generator, of the same voltage and speed as the other two units. These three engines are fitted with the new Franklin valve gear.

No pipes show in the engine room, as the live- and exhaust-steam pipes are attached to the cylinders underneath and drop to the basement, where they connect with the main steam and exhaust lines. The live steam is controlled by means of floor-stand operated valves located conveniently beside the engine cylinders. The engine cylinders are lubricated by force-feed lubricators. The engine oil drains from the engine bearing into a filter located in the basement and is then elevated to an oil reservoir, placed above the smoke flue in the boiler room, thus keeping the oil warm, without the aid of heating coils in the filter.

An interesting device is shown in Fig. 2, midway between the two frames of the twin engines. It consists of a floor stand supporting an arm from which an adjustable hanger containing two rollers is suspended. The cross rod extending from the governor on one side of the engine to the reach rods controlling the valve gear on the other side passes this hanger and is supported at the center by the two rolls, the hight of which can be adjusted by moving the bracket up or down. This prevents vibration, supports the rod and reduces friction.

A gageboard, on which is mounted a clock, steam gages for live steam, steam heating and vacuum, also the water pressure on the city main, is mounted on the wall between the engine and boiler rooms. There is a Laidlaw-Dunn-Gordon 10 and 10 by 10-inch air compressor that supplies air for shop work. The pressure is maintained at 45 pounds per square inch. There is also a 40-horsepower Terry turbine, direct coupled to a Diehl direct-current generator of 25 kilowatts capacity, which runs at a speed of 2500 revolutions per minute. This unit is used for lighting the engine and boiler rooms, and several rooms in the factory building when the main units are shut down.

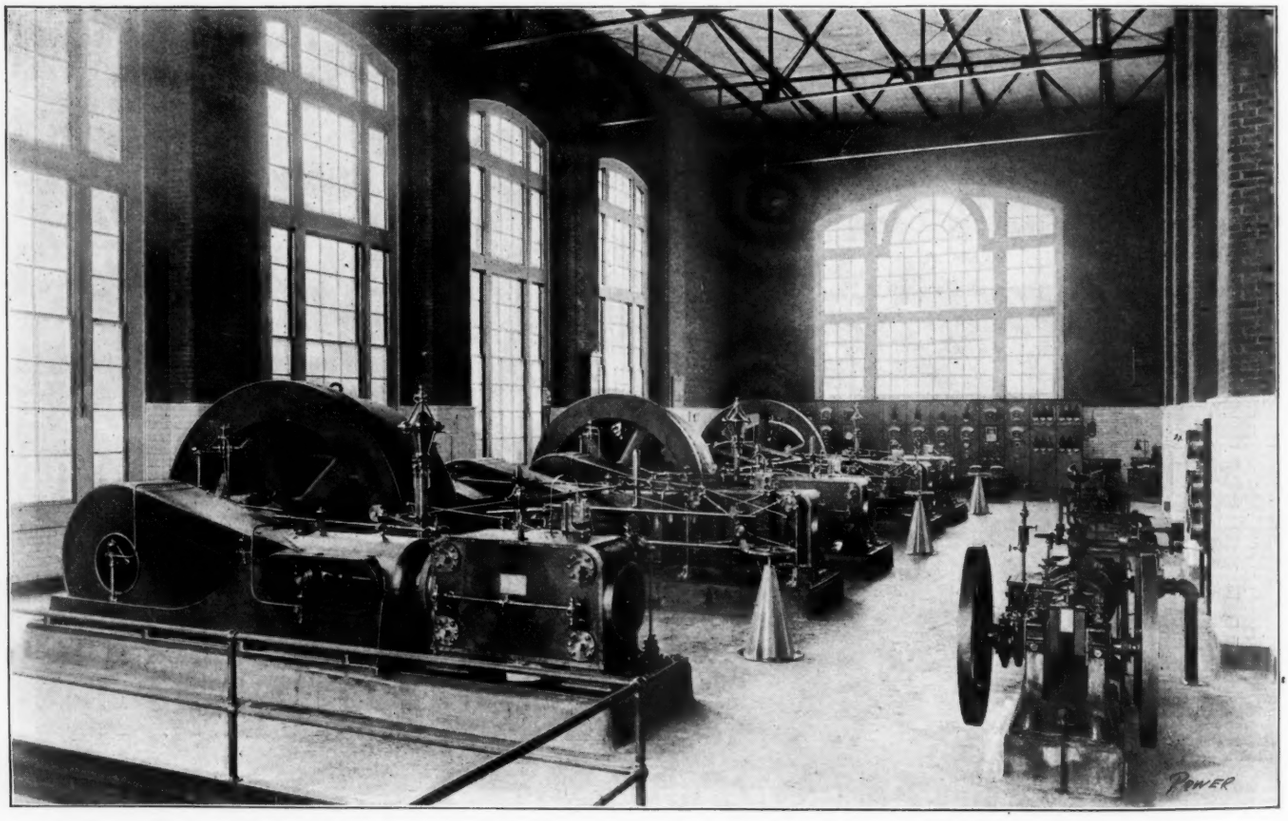


Fig. 1. View of the Engine Room of the New Power Plant of the Dennison Manufacturing Company

The foundations of the twin engines have been so designed that one of the high-pressure cylinders can be removed and a low-pressure cylinder substituted in case it ever becomes necessary to do so. Provision has also been made for installing a receiver between the two cylinders should the engines be compounded.

The switchboard shown in Fig. 3 is located between No. 1 unit and the end wall of the building and is designed in two sections, devoted to motor and lighting circuits, each section having its own recording instruments and circuit-breaker control.

The former plant operated upon 115 volts and in various departments were located 125 motors ranging from 1/10 horsepower to 60, many of these being special motors for variable-speed work and direct connected to special machinery. Provision was made when installing the new plant to keep all motors in use up to and including the 15-horsepower sizes on 115 volts. All motors larger than this size and all new motors were installed for 230 volts.

Both power and lighting circuits are carried into the plant on a three-wire system and two balancers are installed with a capacity of 100 and 200 amperes respectively. The balancers can be run separately on power and lighting circuits or can be operated in parallel.

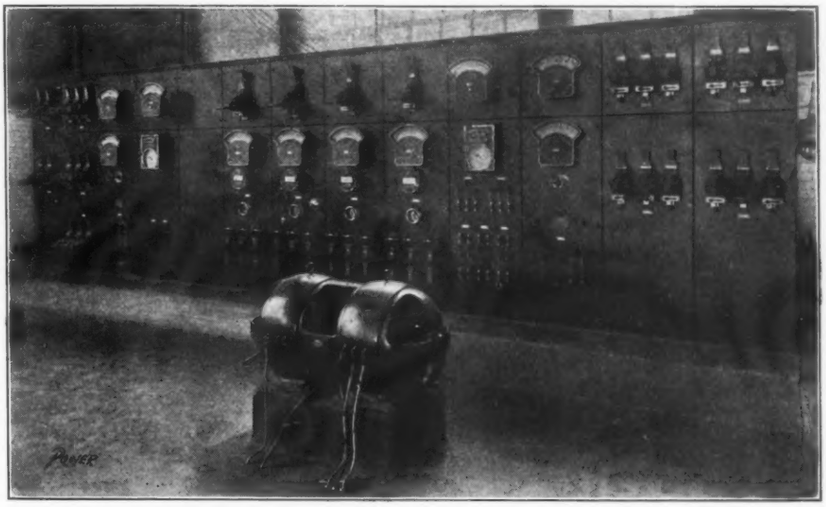


FIG. 3. SWITCHBOARD AND ONE OF THE BALANCING UNITS

BOILER ROOM

In the boiler room, Fig. 4, there are four Wickes vertical water-tube boilers set in two batteries. Each boiler is equipped with a Murphy stoker, with an extended dutch oven giving a large combustion chamber. A smoke flue connects with the bottom of each boiler and extends up to the main smoke flue, which runs the entire length of the boiler room and connects with the 150-foot brick stack, located on the outside of the building.

Each boiler is fitted with a damper in its individual uptake; the main flue is also fitted with a damper which will eventually be operated by a damper regulator and the draft of all the boilers will then be controlled by the one damper.

The settings of these boilers have been built in accordance with the specifications

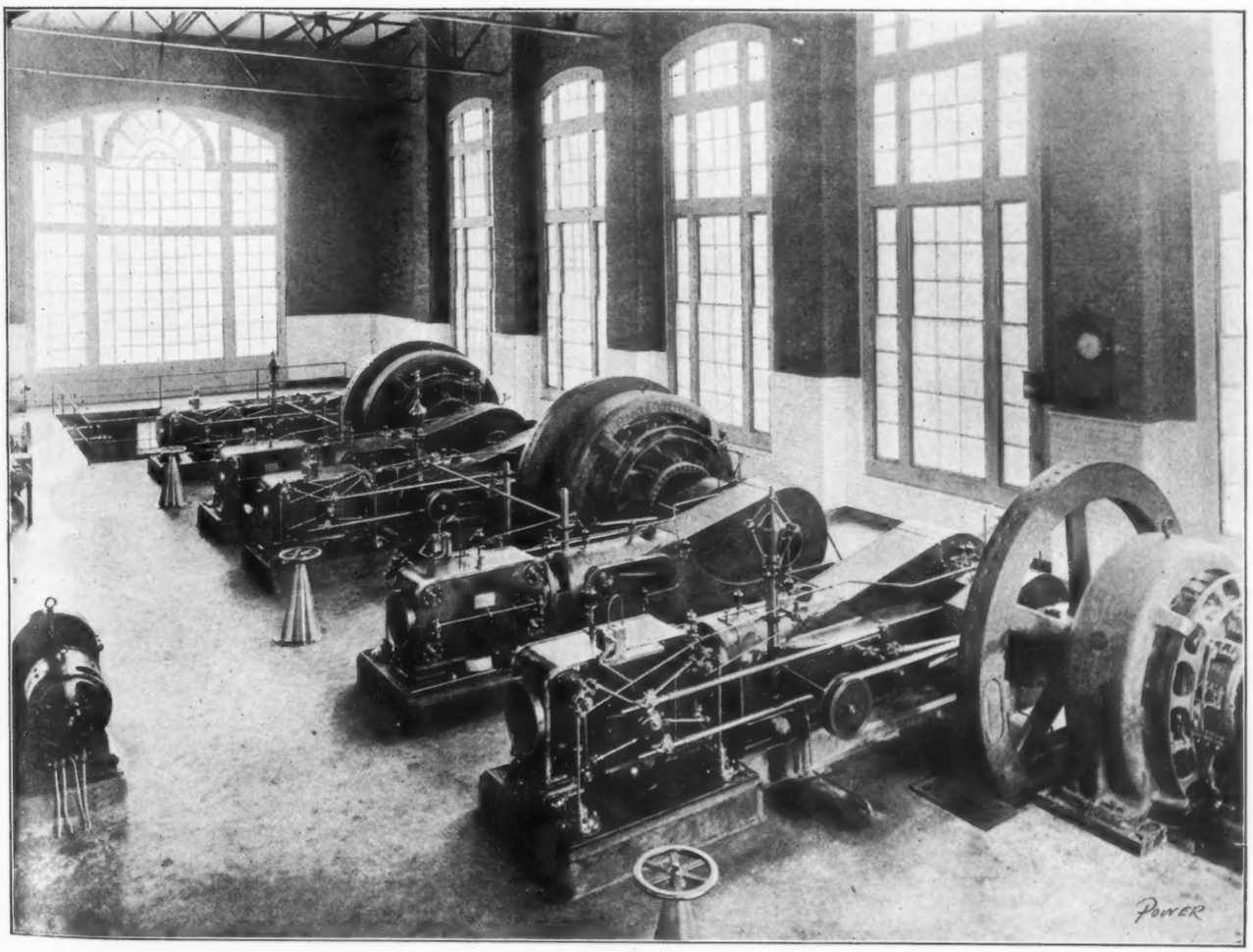


FIG. 2. VIEW OF ENGINES FROM THE GENERATOR SIDE, SHOWING THE GOVERNOR-SHAFT SUPPORT

demanded by the Massachusetts Board of Boiler Rules. Each boiler is set on a concrete base, which is made hollow, as shown in Fig. 5, an end elevation of the engine and boiler rooms. The bottom head of the boiler extends down into this hollow foundation so that it is easily accessible for external inspection, a space having been especially provided opposite the riveted joint of the head and barrel of the boiler, as shown in Fig. 5. This permits of inspection of every rivet of the bottom head joint at any time and decreases the liability of the failure of the joint or the wearing away of the head at this point by external corrosion occurring without being noticed.

Piping

The boiler blowoff pipe extends down from the center of the bottom head and passes out through the concrete foundation, and is fitted with a tee connection, the outer end of which is fitted with a blank. From the side connection of the tee, two valves connect with a Y-connection on the blowoff pipe, as shown by the dotted lines in Fig. 6. The valve nearest the boiler is of the asbestos-packed type; the second is a straight-way valve. All blowoff pipes run under the boiler-room floor and the valve-stem extension rods pass up to and almost through the boiler-room floor; the valve stems are operated by means of a detachable wrench. When not in use the opening over each valve-stem extension rod is covered by a floor plate. This blowoff arrangement is a very desirable feature, as a fireman is not obliged to go down under the boilers when blowing them down, thus reducing the element of danger in case a blowoff pipe should burst.

Steam is taken from the top of each boiler through a 6-inch extra-heavy pipe, fitted with a long radius bend and is led down to a 12-inch steam header, that is supported on suitable concrete piers arranged back of the boilers. The header is divided into two sections by a valve, so that either section can be cut out of service. From this steam header, 7-inch steam pipes are run to the two twin engines and a 6-inch pipe is run to the single engine. Two 8-inch pipes connect the 12-inch main steam header to an 8-inch steam header, which extends from a point under the second twin engine to the pump room, from which the auxiliary units are supplied and from which live steam is taken to feed into the exhaust-steam main in case there is insufficient exhaust steam supplied to the factory.

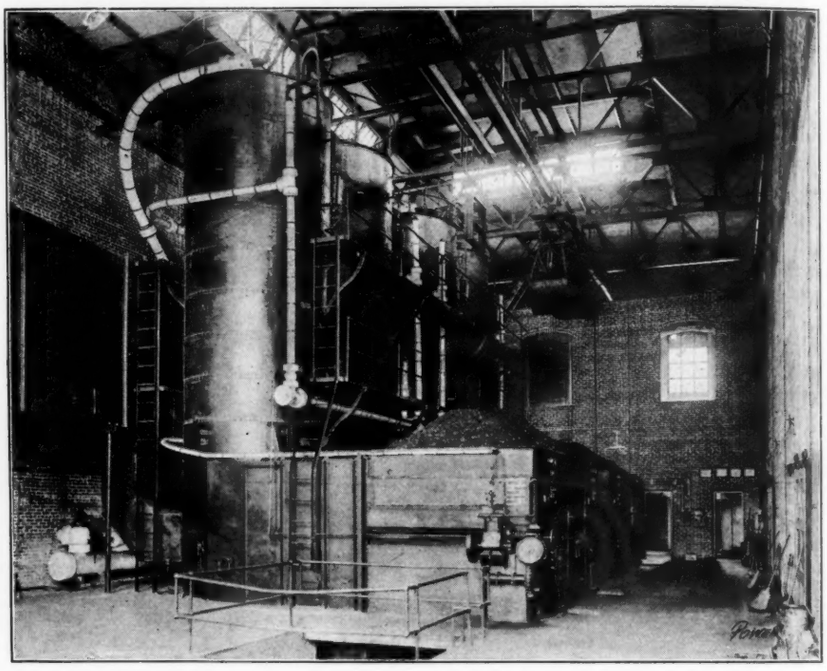


Fig. 4. Boiler Room Containing Four Wickes Boilers

Another live-steam line is tapped to both sides of the cutout valve in the main 12-inch steam header which extends to the pump room located at the front end of the building. The exhaust pipe from the single unit is 7 inches in diameter; it increases to 10 inches for the second unit and to 15 inches at the third engine, beyond which connection is made with a

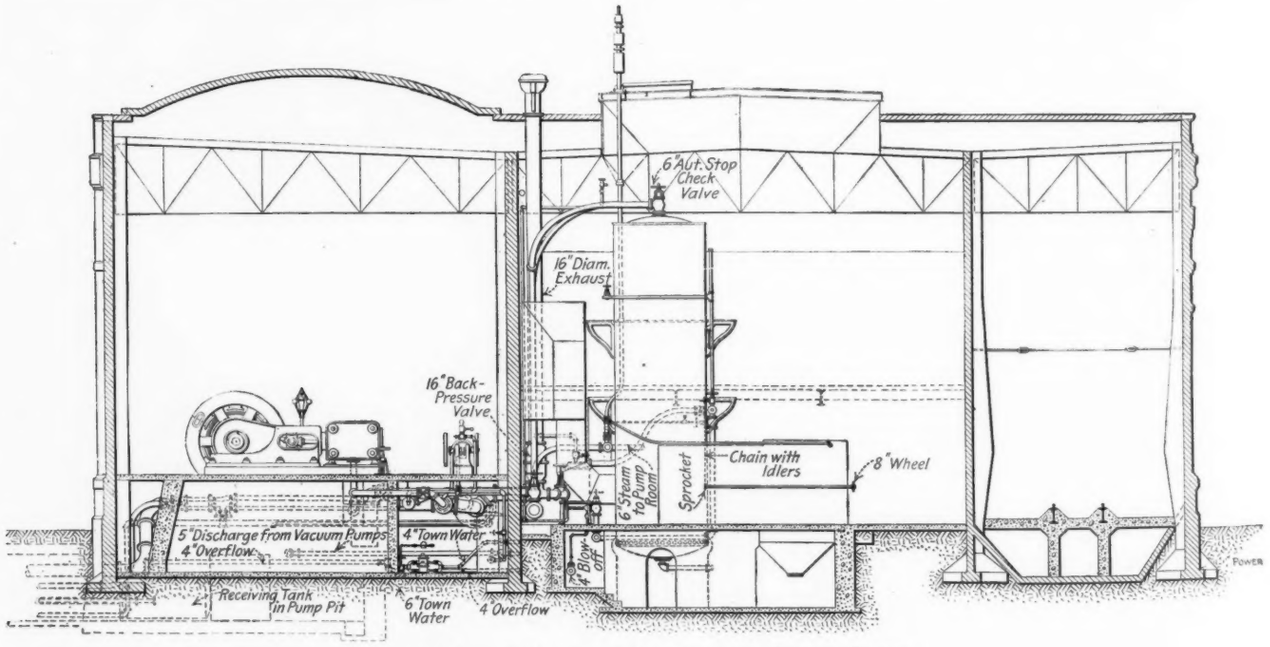


Fig. 5. Elevation of the Engine and Boiler Rooms

17-inch exhaust main, which provides for a future unit and which runs the length of the engine room in the basement toward the front and on to the factory through a tunnel that is 200 feet in length. All wires, pipes for live and exhaust steam, water and air are carried to the factory through this tunnel.

A 16-inch Hoppes oil eliminator is placed in the exhaust line; connection is also made through the wall between the boiler and engine rooms, so that exhaust steam can be passed through a Reilly multicoil feed-water heater. A vertical galvanized, spiral-riveted exhaust pipe extends to the atmosphere and is fitted with an Atwood back-pressure valve; this pipe connects with the exhaust pipe between the main exhaust header and the heater. The general arrangement of the piping is shown in Fig. 6, which also gives a view of the layout of the plant, showing the space reserved for three additional boilers in the boiler room.

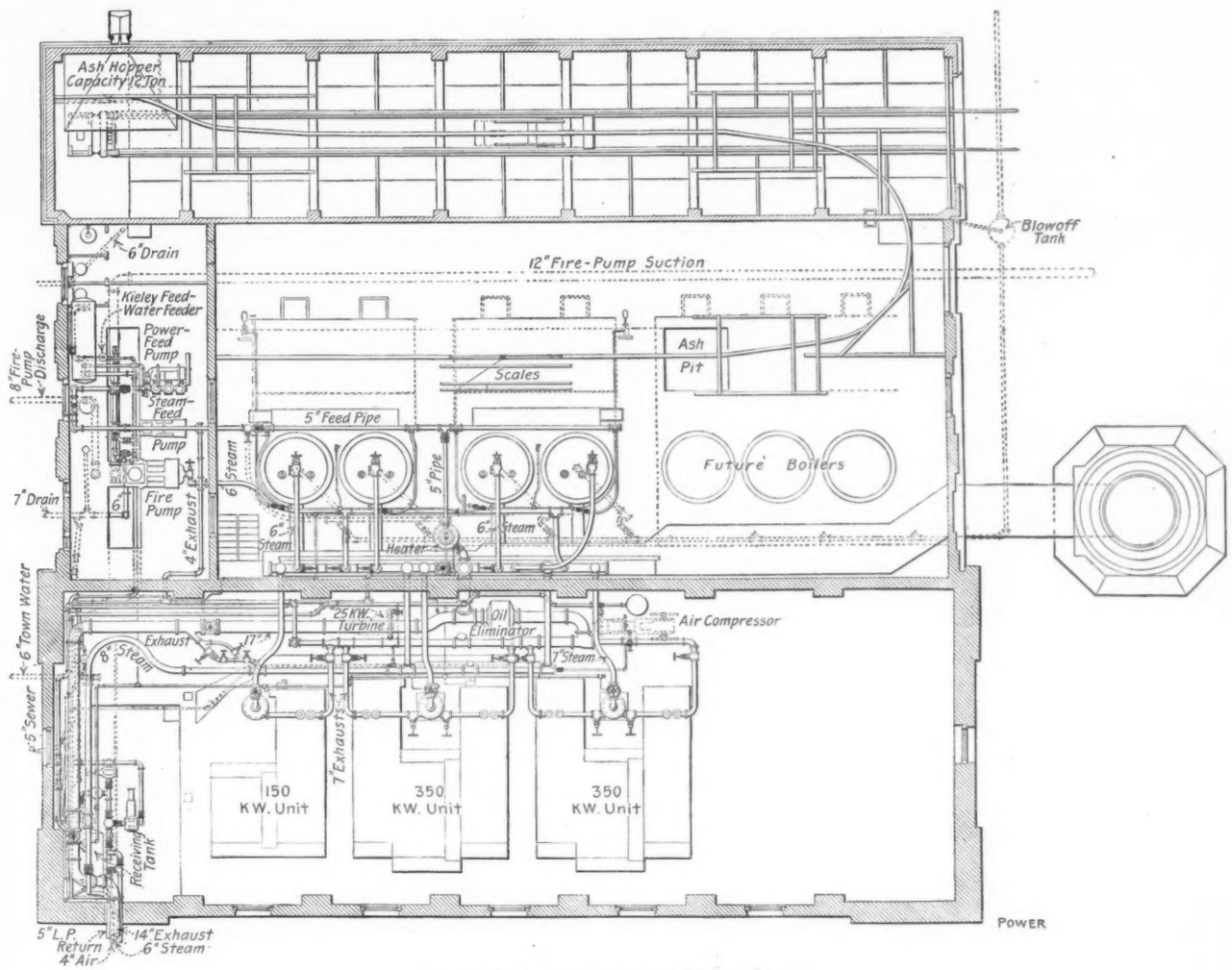


FIG. 6. PLAN VIEW OF THE POWER PLANT

PUMP ROOM

In the pump room there is one Rumsey 6½x10-inch, triple-plunger, motor-driven power pump. This pump is driven by a 20-horsepower Diehl motor with a speed variation of three to one. The speed of the pump is regulated by hand by means of a field control. Surplus is bypassed into the suction pipe by means of a regulator valve. There is also one 12 and 7 by 12-inch Deane duplex pump, used for boiler feeding, when electrical power is not available. Fig. 7 shows the layout of the piping in the pump room.

Fire protection is afforded by a Knowles 18 and 10 by 12-inch duplex pump which has a capacity of 1000 gallons at 70 revolutions per minute. This pump is connected by means of a 12-inch suction pipe to a reinforced-concrete reservoir in the rear of the power house. This reservoir is about 54 feet in diameter and has a capacity of 125,000 gallons of water.

In a pit under the engine-room floor, is an 8 and 10 by 12-inch Blake vacuum pump for handling the returns on the heating system. There is also an 8 and 10 by 12-inch Knowles pump, either one of which can be used on either the vacuum heating system or to pump from a receiving tank. On account of the manner in which these pumps are piped up, either one can take water from the heating system direct and at the same time from the receiving tank, the hight of water in the receiving tank being controlled by a Utility pump governor. Suppose the pump is pumping from the return main of the heating system. As the water in the receiving tank lifts a float ball, a valve is operated in the governor chamber, which permits the water to be drawn from the receiving tank through the governor, until a certain predetermined level has been obtained, when the valve closes, which operation takes place before air can be drawn into the pump cylinder.

FEED-WATER SYSTEM

A feed-water heater is placed between the two batteries of boilers and next to the dividing wall between the engine and boiler rooms. Feed water is taken from the make-up tank and is forced through a Blackburn-Smith feed-water filter and the heater to the feed line. The feeding of water to the boilers is regulated by means of a handwheel and shaft, the latter extending to a point under the vertical

feed pipe and connection made to a sprocket wheel on the valve stem by means of a chain. This enables the fireman to regulate the water from the front of the boiler furnaces.

The 5-inch brass feed-water main extends along the front of the boilers, and vertical pipes are run up and over to the rear of the boiler, connecting near the top; a tee joint is placed where the vertical and horizontal branch pipes connect and a vertical piece of pipe, capped at the top end serves as an air chamber to prevent water hammer in the feed pipe.

Coal and Ash

Coal is delivered to the stokers by means of a ¾-ton Sprague electric traveling conveyer, which runs on a suspended track reaching from one end of the coal shed its entire length and, making a curve at the stack end of the plant, extends back over the stokers of the boilers. Before the bucket discharges its load, the coal is weighed on a Fairbanks scale which enables a tally to be kept on the amount of coal delivered and the amount burned each day. A spur track extends the length of the coal room on heavy beams and the coal is discharged into the pit below the rails. The coal shovel is of such proportions that it can be dropped between the rails when picking up its load.

Under the boiler-room floor, and directly under the outlet of the ashpits, which are made with slanting sides, is an industrial car track, on which an ash car runs. When ashes are to be removed, they are dumped into this car, which delivers them to the ashpit, shown in Fig. 6. From the ashpit the traveling coal bucket picks up the ashes and conveys them to an ash hopper, shown in Fig. 6, located at the extreme end of the coal shed. This hopper has a capacity of 12 tons and is fitted with a gate on the outside of the building, so that the ashes can be readily loaded into a wagon and carted away.

The author is indebted to the engineering staff of the Dennison Manufacturing Company for data and illustrations concerning this installation.

License Agitation in Rhode Island

By William E. Francis

In Rhode Island, as in many other States, boiler-inspection and engineers'-license legislation is being urged by progressive engineers. That these efforts are meeting with a great deal of opposition from those who imagine that their interests are threatened, is evidenced by the statements made by persons who were called before the House Judiciary Committee on the afternoon of March 29, where it was disclosed by evidence that there are two steam boilers in use at the Technical High School which are considered dangerous and which, though made in Massachusetts, the manufacturers admitted at the time of putting them in do not comply with the Massachusetts law and could not be used in that State.

Among others who appeared before the committee was B. McCabe, of Boston, Mass., who said he was opposed to the bills and that he had come to the hearing to intercede for the engineers and to save the public of this State from the troubles which had been experienced in Massachusetts. The object of the bills, he said, was to legislate certain men out of positions. He told of the injustice which he claimed the law had worked in the neighboring State, in depriving good men of positions they held in order that someone else might get them.

After the hearing, one of the aldermen said that he was unaware that anything was wrong with the boilers but that about a year ago his attention was called to the fact that the building was being heated with condensed steam and that there was a big waste because the return steam could not be used. This was due to the poor circulation of the oil in the boilers and a leakage in the tubes sometimes resulted. Large quantities of caustic soda had to be used in order to prevent this and a request was made for an oil filter. This was obtained and since that time he has heard no complaint as to the condition of the heating apparatus. Continuing along these lines he further said that the boilers consumed an extravagant amount of coal and that it cost more to heat the Technical school building than it did to heat all the buildings of the new City Hospital.

One thing stands out quite prominently: The statement of the engineer in charge that these boilers, bought and installed in the Technical High School building, were known to be at the time of installation of such construction as would not meet the requirements of the Massachusetts boiler-inspection laws. This would appear to be poor business policy, but if the board having this matter in charge was as intelligent as regards engineering subjects as the alderman quoted, it can be easily understood. It is a little surprising to learn that a Boston man spoke against the bill on the ground that it intended to legislate good men out of positions, that others might get them

License laws are usually intended to keep out the poor men, not the good ones. I once met a bright appearing young fellow who had served as an oiler in a power house for three months and who intended to take an examination for a second-class engineer's license. He was very positive that he knew all about getting a license.

"This license business is all graft," he said. "Take a pint of whisky with you and you get your license." I guess he forgot to take along the whisky, for he didn't get so much as a fireman's license and as a result is very bitter against the license laws.

Is this the kind of good men who will be kept out of positions by the license law? The objection of a Boston man who said that the grading of licenses by classes is class legislation and unconstitutional is absurd. The claim is often made that a man who can handle a 50-horsepower plant of a certain type can handle a 500- or 1000-horsepower plant of the same type. While this should hold good in theory, it does not in practice, hence classification is advisable.

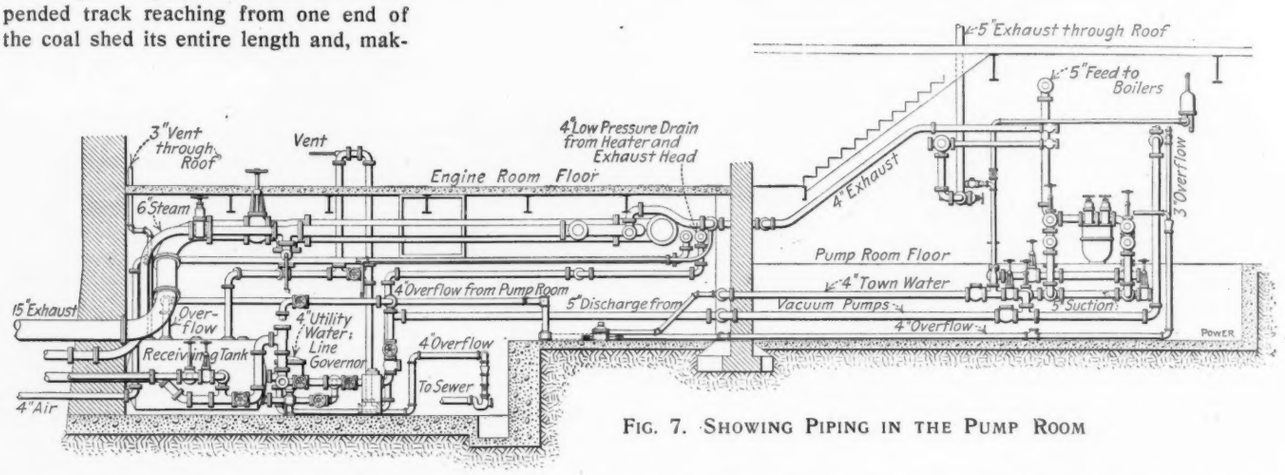


Fig. 7. Showing Piping in the Pump Room

Overcoming Shortage in Feed Water

The water supply to a large power plant was suddenly cut off, owing to drought. By means of locomotives, tank cars and an oil barge enough water was supplied to keep the plant in operation until a permanent water supply was obtainable.

"Is this Mr. Wildin, mechanical superintendent of the New York, New Haven & Hartford Railroad? Well, this is Mr. Peterson, chief engineer of the Cos Cob central station. The Greenwich Water Company has just notified me that it will be obliged to shut off our water supply in 15 minutes as their supply has run dry."

While this was not the actual conversation that took place over the telephone three days before Christmas of 1910, it presents the important point, that owing to the exceedingly dry season throughout Connecticut last fall, the Greenwich Water Company's water supply failed, which necessitated cutting off the supply to the Cos Cob water plant of the New York, New Haven & Hartford Railway, with but 15 minutes' notice.

FIG. 1. LOCOMOTIVE PUMPING AIR INTO TANK CAR, FORCING WATER INTO THE RESERVOIR

This power plant supplies electrical current to electric locomotives running between Mott Haven, N. Y., and Stamford, Conn., a distance of about 20 miles. All passenger trains are drawn by electric locomotives over this stretch of track, and shutting down the power plant meant a suspension of passenger traffic until steam locomotives could be put in commission.

Without water, it would be impossible to keep the steam plant going and with Christmas but three days away, when the passenger service would be taxed to its utmost, the power plant could not be shut down; it just had to run.

There was no time to sit down and cuss the weather or fate. Action was required, and quick work at that. The first thing Mr. Wildin did was to order out the wrecking train with a supply of piping and a locomotive water tank placed on a platform car which was run onto a siding at the power plant and the tank deposited on the ground near the concrete reservoir shown in Fig. 1. At the same time four freight locomotives were despatched from New Haven, each with a tank full of water, and by the time they arrived at the plant, a temporary pipe line had been run from the siding at the end of the boiler room in through the door, around to the back of the boilers to a hotwell that was located below the boiler-room floor at the extreme end of the building. This pipe line consisted of boiler tubes that were kept on hand for repairs. They were placed end to end, the joints plastered with putty and wrapped with rubber and burlap. One of the freight engines was run to a point opposite the end of the pipe line at the boiler house. The injector was started, but the water was allowed to escape through the overflow pipe into the pipe line running to the hotwell. This, together with a portion of the salt circulating water, which made the water somewhat brackish, was sufficient to keep the wheels moving, which was the main thing.

While this makeshift was keeping the plant in operation, two of the locomotives were placed at a point opposite the cement water tank that held 600,000 gallons of water.

When word was received that the supply had failed, about one-half of this supply ran back into the water main of the water company before the valves could be shut. As about 12,000 gallons of water were used per hour, it was a necessity to get this reservoir filled in order to have a reserve supply. The discharge pipes of the injector on these locomotives were connected to a line of wrought-iron pipe that ran to the concrete reservoir, and the water in the tank was injected into the cement reservoir at a rate of about 12,000 gallons per hour.

This gave two sources of water supply; but, in order to be on the safe side,

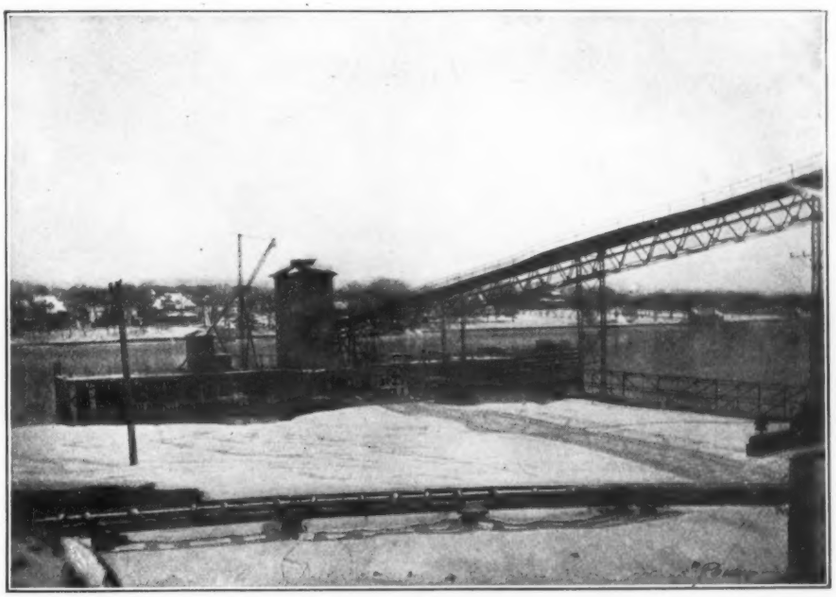


FIG. 2. OIL BARGE LOADED WITH WATER FOR THE POWER PLANT

20 tank cars were put into service drawing water from Stamford, four miles distant. When these arrived in trains of six cars each, one car was allowed to discharge its contents into the pipe leading to the hotwell. Two other tank cars discharged their contents into the water tank, from which it was pumped into the concrete reservoir by means of a steam pump that had been loaned by a contractor. This pump was supplied with steam from the boiler room through a temporary pipe line run on the ground. Two other cars were placed opposite the reservoir and the outlet connected to pipes leading to the cement reservoir. The locomotives were supplied with two air connections, one on the front and one on the rear end of the engine. Each of these air pipes was connected to the top connection of a tank car. The air pump on the engine was started with the air valve so set that a pressure of 30 pounds per square inch was maintained. This air pressure on the water in the tank car forced it up into the reservoir, and as each car held 8000 gallons, the reservoir was filled by Saturday morning, less than 48 hours after the water supply failed. As there was no knowing how long the water famine would last, it was decided to utilize another method of supplying water; therefore, an oil barge having a capacity of 200,000 gallons was obtained. A 3-inch pipe was run from the reservoir to the oil barge that was tied up to the coal-delivery pier, shown in Fig. 2. A steam pump on the barge, supplied with steam from a tug accompanying it, pumped the water into the reservoir through this pipe. A 2½- and a 2-inch fire hose were also used. After the reservoir was once filled, all but the 3-inch pipe was removed, the engine and tank cars were put back to their legitimate service and the barge of water kept up the necessary supply, although but two barges could be delivered per day owing to a sand bar at the mouth of the river which necessitated the barge coming in at high tide.

Due to these methods, the plant was kept in operation, the public was not incommoded, and the operating officers of the road were well pleased with the able way in which a most difficult problem had been handled.

The writer is indebted to G. W. Wildin, mechanical superintendent, for the foregoing details, who not only directed the work, but lived on the job until all danger of a possible shutdown had been avoided.

The Old Mill at New London, Conn.

There are many historical points of interest scattered through the New England States. Some of them date back to the settler days and their traditions are interwoven with romance and legend. The "Old Mill" now running at New London, Conn., and illustrated in Fig. 1, takes a prominent place among the many historical relics of days long past. It was built in 1650, after a special town meeting, held for the purpose of considering the question of erecting a mill to grind corn for the settlers. Gov. John Winthrop was the leading spirit of this new enterprise. Under his supervision the plans were perfected. The erection of a dam and the mill on his estate, then called Winthrop's Neck and now East New London, was the outcome.

This old grist mill was built under the direction of Governor John Winthrop in 1650. For 261 years it has been grinding corn into meal. It is 19 feet in diameter and is 6 feet 8 inches in width.

Six men were appointed to build the dam and mill and they were instructed to make it "substantial and sufficient." They did so, for the original wheel was in use up to four years ago, when it was supplanted by a new one. The old framework of the mill appears to be as solid now as on the day it was put in place. The management of the mill in the old days savored somewhat of the trust methods of today, for with the building of this mill it was agreed that:

"No person or persons should set up any other Milne to grind corn for the town of Pequott within the limits of the town, either for the present nor for the future so long as John Winthrop or his heirs do uphold a milne to grind the town's corn."

The old mill is located beside a rocky glen, and the flow of water is through an iron pipe to a sluiceway that is supported by a trestle illustrated by Figs. 2 and 3, and upon reaching the overshot waterwheel, fills the buckets.

FIG. 1. THE OLD MILL AT NEW LONDON, BUILT IN 1650

FIG. 2. SLUICEWAY RUNNING FROM THE DAM TO THE WATERWHEEL

The water is controlled by a gate valve in the iron-pipe outlet and by a trap gate in the sluice. This gate is hinged on the end next to the waterwheel and is held up at the other end by means of a rod and lever which reaches into the mill. This allows the water to flow through an opening in the bottom of the sluiceway on the inverted buckets of the wheel. When it is desired to run the wheel the gate is dropped and the water then flows to the end of the sluice and into the buckets of the wheel. After leaving the wheel the water flows through a raceway into the bay fronting the city of New London. All surplus water not used by the wheel passes over a low portion of the dam and after dashing over and around the rock-studded glen, flows into the bay.

FIG. 3. SLUICEWAY AND SUPPORTING TIMBERS

The wheel has a diameter of 19 feet and is 6 feet 8 inches wide. The outer rims which support the buckets are secured to wooden spikes which fit into a hub 26 inches in diameter. The hight of each bucket is 15 inches, the width 10 inches and the length 6 feet 8 inches. The wheel runs at a speed of 15 revolutions per minute, and it is estimated develops approximately 18 horsepower with a full head of water. The capacity of the mill is between 40 and 50 bushels of meal per hour. The old mill is now operated by George H. Smith, of New London.

The dam is now covered by a wide gravel walk. The old Winthrop home site is now occupied by the modern Winthrop public school. The old wheel has been replaced by a new one and the building has been so repaired that but little remains but the old timbers and inside woodwork that made up the framework of the structure.

One can scarcely imagine that this old mill has stood so many years or that it has witnessed so many exciting scenes. It stood through the shedding of revolutionary blood. It has looked upon the warships of England and the Indians creeping through the thick undergrowth of the forest. Today it looks out from the glen upon a city, and still performs its mission, grinding corn in the same old way that it did 261 years ago.

Boiler Room Bulletin

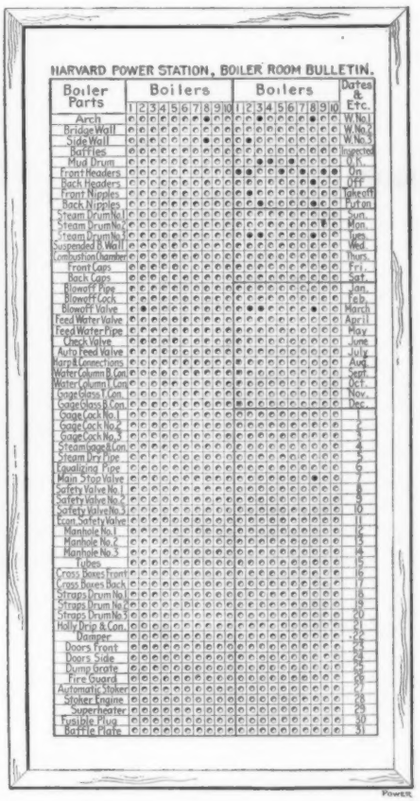
E. B. Ford, the chief engineer of the Harvard power station of the Boston Elevated Railway Company, Cambridge, Mass., has a boiler bulletin which shows at a glance the status of every boiler in the plant.

This bulletin consists of a board in which there are 20 vertical rows of holes. A number of plugs have been prepared and enough are inserted in the different holes to give all the information required about every boiler in the plant.

In the column headed Boiler Parts is a complete list of all the parts of the Babcock & Wilcox boiler. This column could be made to apply to other boilers also. There are 10 boilers and each one has two columns of holes on the board. When a boiler is in operation and it is found that some particular part needs repair, the man in charge puts a plug in the column of the boiler number, and opposite the name of the part needing repair, on the left half of the board. For example, No. 2 boiler is in operation and it is found that the blowoff valve needs repair; the man finding this would plug the column for No. 2 boiler opposite the blowoff line. Then when the boiler is out of operation it may be readily seen what is to be done.

At the right of the board there is also a set of columns for each boiler. On this side a record is kept of the watch; the day of the week and the month that the boiler is either taken off or put on the line. On this side also there is a method by which the chief engineer can notify the watch engineers at what watch day of the week or the day of the month a boiler is to be put on or taken off the line. This is accomplished by plugging the put-on or take-off line.

Referring to the bulletin it is seen that boilers 1, 2, 5, 7, 9 and 10 are in operation but that the blowoff on No. 2 needs attention, and therefore is to be cut out of the line on the third watch on


HARVARD POWER STATION, BOILER ROOM BULLETIN.

Boiler Parts	Boilers 1 2 3 4 5 6 7 8 9 10	Boilers 1 2 3 4 5 6 7 8 9 10	Dates & Etc.
Arch	e e e e e ● ● e e e	e ● e e e e e ● e e	W.No.1
Bridge Wall	e e e e e e e e e e	e e e e e e e e e e	W.No.2
Side Wall	e e e e e ● e e e e	e e e e e e e e e e	W.No.3
Baffles	e e e e e e e e e e	e e e e e e e e e e	Inspector
Mud Drum	e ● e ● e e e e e e	e e ● ● e e e e e e	U.S.
Front Headers	e e e e e e e e e e	e ● e e ● e ● e ● e	On
Back Headers	e e e e e e e e e e	e e e e e e ● e e e	Off
Front Nipples	e e e e e e e e e e	e ● e e e e e e e e	Takeoff
Back Nipples	e e e e e e e e e e	e e e e e e ● e e e	Put on
Steam Drum No.1	e e e e e e e e e e	e e e e e e e e e e	Sun.
Steam Drum No.2	e e e e e e e e e e	e e e e e e ● e e e	Mon.
Steam Drum No.3	e e e e e e e e e e	e e ● e e e e e e e	Tues.
Suspended F. Wall	e e e e e e e e e e	e e e e e e e e e e	Wed.
Combustion Chamber	e e e e e e e e e e	e e e e e e e e e e	Thurs.
Front Caps	e e e e e e e e e e	e e e e e e e e e e	Fri.
Back Caps	e e e e e e e e e e	e e e e e e e e e e	Sat.
Blowoff Pipe	e e e e e e e e e e	e e e e e e e e e e	Jan.
Blowoff Cock	e e e e e e e e e e	e e e e e e e e e e	Feb.
Blowoff Valve	e ● e e e e e e e e	e e ● ● e e e ● e e	March
Feed Water Valve	e e e e e e e e e e	e e e e e e e e e e	April
Feed Water Pipe	e e e e e e e e e e	e e e e e e e e e e	May
Check Valve	e e e e e e e e e e	e e e e e e e e e e	June
Auto Feed Valve	e e e e e e e e e e	e e e e e e e e e e	July
Harp & Connections	e e e e e e e e e e	e ● e e e e e e e e	Aug.
Water Column & Con.	e e e e e e e e e e	e e e e e e e e e e	Sept.
Water Column Cock	e e e e e e e e e e	e e e e e e e e e e	Oct.
Gage Glass I Con.	e e e e e e e e e e	e e e e e e e e e e	Nov.
Gage Glass B Con.	e e e e e e e e e e	e e e e e e e e e e	Dec.
Gage Cock No.1	e e e e e e e e e e	e e e e e e e e e e	1
Gage Cock No.2	e e e e e e e e e e	e e e e e e e e e e	2
Gage Cock No.3	e e e e e e e e e e	e e e e e e e e e e	3
Steam gage & Con.	e e e e e e e e e e	e e e e e e e e e e	4
Steam Dry Pipe	e e e e e e e e e e	e e e e e e e e e e	5
Equalizing Pipe	e e e e e e e e e e	e e e e e e e e e e	6
Main Stop Valve	e e e e e e e e e e	e e e e e e ● e e e	7
Safety Valve No.1	e e e e e e e e e e	e e e e e e e e e e	8
Safety Valve No.2	e e e e e e e e e e	e e e e e e e e e e	9
Safety Valve No.3	e e e e e e e e e e	e e e e e e e e e e	10
Econ. Safety Valve	e e e e e e e e e e	e e e e e e e e e e	11
Manhole No.1	e e e e e e e e e e	e e e e e e e e e e	12
Manhole No.2	e e e e e e e e e e	e e e e e e e e e e	13
Manhole No.3	e e e e e e e e e e	e e e e e e e e e e	14
Tubes	e e e e e e e e e e	e e e e e e e e e e	15
Cross Boxes Front	e e e e e e e e e e	e e e e e e e e e e	16
Cross Boxes Back	e e e e e e e e e e	e e e e e e e e e e	17
Straps Drum No.1	e e e e e e e e e e	e e e e e e e e e e	18
Straps Drum No.2	e e e e e e e e e e	e e e e e e e e e e	19
Straps Drum No.3	e e e e e e e e e e	e e e e e e e e e e	20
Holly Drip & Con.	e e e e e e e e e e	e e e e e e e e e e	21
Damper	e e e e e e e e e e	e e e e e e e e e e	22
Doors Front	e e e e e e e e e e	e e e e e e e e e e	23
Doors Side	e e e e e e e e e e	e e e e e e e e e e	24
Dump Grate	e e e e e e e e e e	e e e e e e e e e e	25
Fire Guard	e e e e e e e e e e	e e e e e e e e e e	26
Automatic Stoker	e e e e e e e e e e	e e e e e e e e e e	27
Stoker Engine	e e e e e e e e e e	e e e e e e e e e e	28
Superheater	e e e e e e e e e e	e e e e e e e e e e	29
Fusible Plug	e e e e e e e e e e	e e e e e e e e e e	30
Baffle Plate	e e e e e e e e e e	e e e e e e e e e e	31

Tuesday, March 7, while Nos. 3 and 8 are to be cut in by the first watch of the same day, after the arch and side walls have been put in good order.

Much has been said from time to time regarding "theory and practice," but the following extract from an address by R. S. Hale, at a recent meeting of the National Electric Light Association, seems to sum up the whole thing in a nutshell:

"A theory is a statement of a case that should consider all the facts, but often does not; hence the results of using such a theory may be bad. On the other hand, good practice, if it is good practice, takes into consideration all the facts in deciding what to do, even omitting some of them from its statement. Therefore, good practice is better than bad theory; but a correct theory that takes into account all the facts is necessarily the best practice."

Captain Charles H. Manning

One of the most prominent mechanical engineers in New England is Capt. Charles H. Manning. His reputation, however, is not local, for he has been associated with such engineers as Haswell, Isherwood, Kafer, Loring, Melville, Thurston and others, some dead, some living, and is known to hundreds of steam engineers throughout the country.

Captain Manning is the son of Joseph C. Manning and Rebecca Parkman Jarvis (Livermore) Manning. He was born in Baltimore, Md., June 9, 1844. His early education was received in private schools in Baltimore, in the high school of Cambridge, Mass., and in 1860 he entered the Lawrence Scientific School of Harvard University to study civil engineering

In the fall of 1861 he returned to Baltimore, due to business reverses brought on by the war, and became an apprentice in the marine-engine works of Charles Reeder. While there he met many officers of the naval-engineer corps, and as a result he was appointed third assistant engineer of the Navy, February 19, 1863.

His vast knowledge of scientific matters brought him to the attention of Chief Engineer Isherwood, who assigned him to the making of experiments on superheating steam on the "Adelaide" and other vessels. As a consequence, Captain Manning's active service "under fire" was confined to some brief fighting in Hampton Roads. He served on the "Adelaide" for two years, when he left her to join the sloop-of-war "Dacotah," and later served on other vessels of war. In 1870 Captain Manning was assigned to shore duty as an instructor at the Naval Academy, where he remained five years. While serving as instructor, Manning assisted in organizing a course of instructions for cadet engineers at the academy, which in his own estimation and that of others is one of his most valuable achievements.

Captain Manning served as a member of the first Advisory Board, in 1881, which body prescribed the first general characteristics of the warships of what was termed the new navy. Other members of the board were Rear-Admiral John Rogers and Chief Engineers Benjamin F. Isherwood and Charles H. Loring. Captain Manning has the distinction of being the only engineer on the board who had the courage to vote for steel vessels.

Captain Manning was granted a year's leave of absence in 1882, after 12 years of continuous duty. He immediately accepted a position as mechanical engineer of the Amoskeag Manufacturing Company, Manchester, N. H., the largest of the cotton mills in the world. This position he now occupies.

In 1884 Manning was placed on the retired list of the Navy, to the regret of his engineering associates. During the Spanish-American war, when he was 54 years of age, he was again called into active service and was stationed at the naval station at Key West, as chief engineer of repairs of the machinery on warships which gathered there.

The position now held by Captain Manning is of importance and calls for more than ordinary skill. Besides having charge of all the power plants of the company, he is in addition the architect and builder of the new Coolidge mill recently completed. Something of the extent of his duties can be gathered from the following:

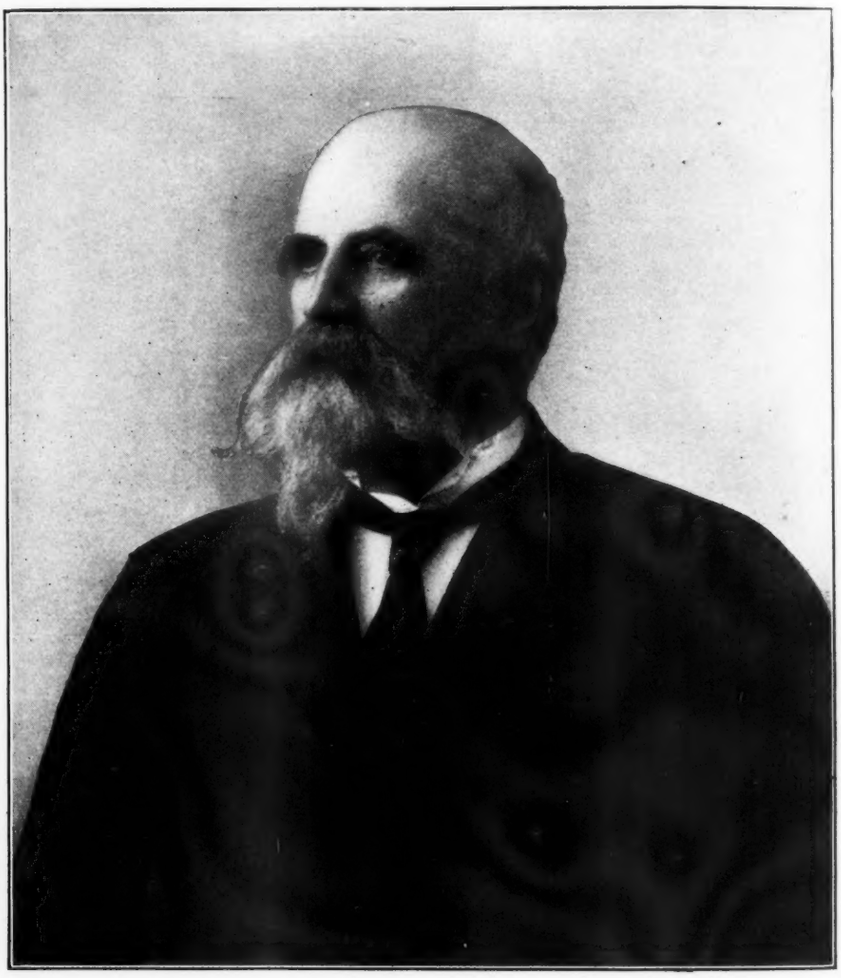
To operate the 110 acres of mill area there are 16,488 horsepower of water turbines, 24,800 horsepower of steam engines and 17,500 horsepower of steam turbines. To supply the steam units, and to produce steam for manufacturing purposes, there are installed 65,700 nominal horsepower of boilers. These are all of Captain Manning's design.

Manning was the pioneer in designing and installing in 1885 a 2000-horsepower horizotal water turbine, the first large installation of its kind.

The resourcefulness of Captain Manning has never been questioned. In the fall of 1891, a 30-foot flywheel burst and, being dissatisfied with the metal put into the rim of flywheels at that time, he designed a new 30-foot flywheel, with a face of 108¼ inches and a thickness of 12 inches. This rim was made up of 44 rings of ash. This was doubtless the largest wooden-rim wheel in the world. The wheel is still in operation after a service of 20 years.

In addition to his position with the Amoskeag company, Captain Manning is consulting engineer for several other large mills. He is a past vice-president of the American Society of Mechanical Engineers. He is also a member of the Army and Navy Club of New York, American Society of Naval Engineers, United States Naval Institute, American Society of Naval Architects and Marine Engineers, American Association for the Advancement of Science and the American Society of Cotton Manufacturers.

Captain Manning's career has been brilliant. He is known as a man of sterling qualtities, of a manly and generous nature, one of the men whose friendship is well worth cultivating.



CHARLES H. MANNING, MECHANICAL ENGINEER OF THE AMOSKEAG MANUFACTURING COMPANY

Desirable Improvements in Boilers

By F. W. Dean*

Boiler joints, settings, heating surface, factor of safety, elastic limit, vertical boilers, large units and blank flanges on pipes are the topics touched upon by the author.

*Mill engineer and architect of Boston.

A few years ago I advocated before the American Society of Mechanical Engineers the adoption by boiler designers of a longitudinal joint having all rivets in double shear, and getting all the rivets as near the center line of the joint as practicable. The lap joint is now well understood to be almost the sole cause of boiler-shell explosions, and any joint which gives one-sided resistance to rupture is likely to cause explosions at some time. The form of butt joints commonly used in this country, that is to say, those with narrow outside and wide inside straps, is of that class. A part of the joint is lapped and in that part the rivets are overhung and in single shear. These rivets are poor things for resisting a pull, and the whole joint may be deformed under strain. The result of this is that longitudinal cracks may occur in the joint due to bending by steam pressure, and changes in the bending by changes in the pressure. I think that the ruptures of the joints at Woonsocket and Torrington were hastened, if not caused, by this action. I expect to see this form of butt joint abandoned.

In the paper referred to I advocated a form of butt joint in which both straps were of the same width and all rivets in double shear. The pitch of the outside row was wide, but the outside strap was thick enough to render calking effective. The efficiency of such a joint cannot well be over 85 per cent., and in this respect is hardly satisfactory. Fig. 1 shows a design of a Scotch boiler having joints of this design, made by me for the Deer Island station of the Metropolitan Water and Sewerage Board of Massachusetts.

More recently I have adopted as my regular practice an extension of the same idea, taking the form used on the S. S. "Kaiser Wilhelm der Grosse" some 15 years ago. I understand that this is the form of joint used in Germany quite generally. It is easy to obtain an efficiency of about 92 per cent. with it, and it fulfils every ideal. This form of joint is shown in Fig. 2, which is a design of an 84-inch horizontal return-tubular boiler for 185 pounds of steam, which I made for the Diamond State Fiber Company, of Bridgeport, Montgomery county, Penn. The extra cost of this joint is insignificant. Other features of this design may be interesting; for example, the thinning of the plates at the circular seams so that the double thickness will not exceed well established limits.

Boiler Setting

Recently there were published in POWER two articles on the proper method of setting horizontal return-tubular boilers. With these articles I agree in the main, but I am a very strong advocate of the method of covering the back connection which I show in Fig. 3, which has been standard in my office for many years. It

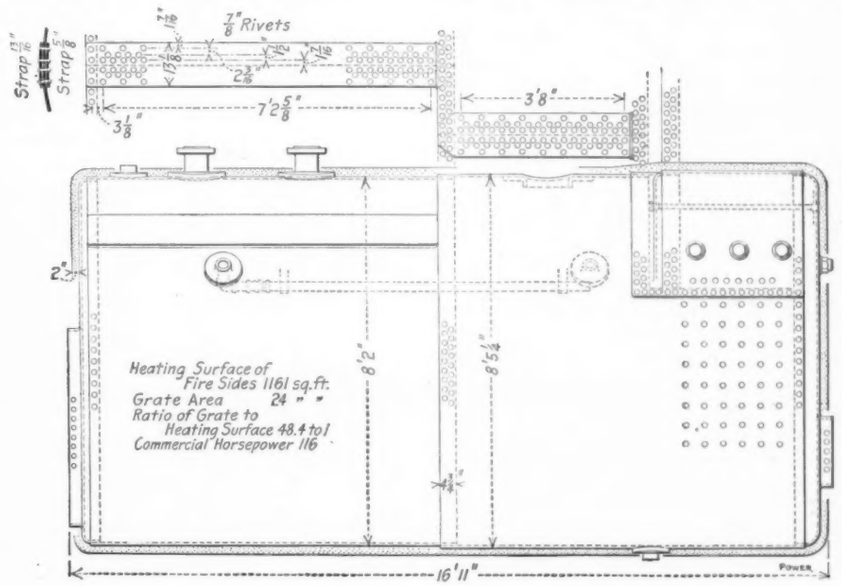


FIG. 1. METHOD OF RIVETING 116-HORSEPOWER SCOTCH BOILER

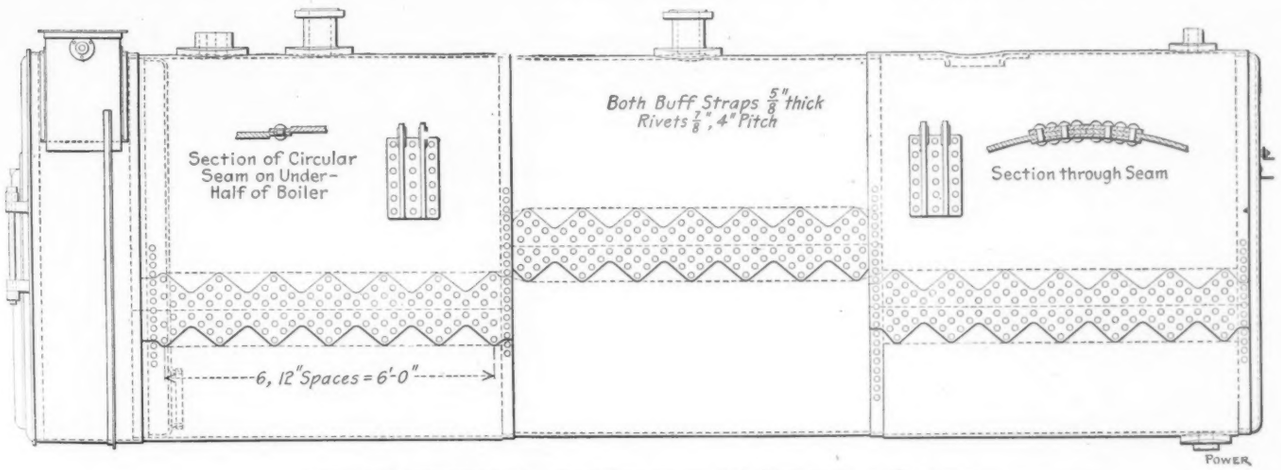

Section of Circular Seam on Under-Half of Boiler
Both Buff Straps 5/8" thick
Rivets 7/8", 4" Pitch
Section through Seam
6, 12" Spaces = 6'-0"
POWER

FIG. 2. HORIZONTAL 84-INCH BOILER OF 300 HORSEPOWER CAPACITY

consists of some long slabs of firebrick which cover the back connection and slide back and forth over it as the boiler expands and contracts. It is pushed back by the boiler and pulled forward by the angle on the underside of the outer end of the steel plate above the slabs. The steel plate protects the slabs from breakage when walked upon. When boilers are set with this feature the cracking of the walls at the back end is prevented, as there is nothing to push them as the boiler expands.

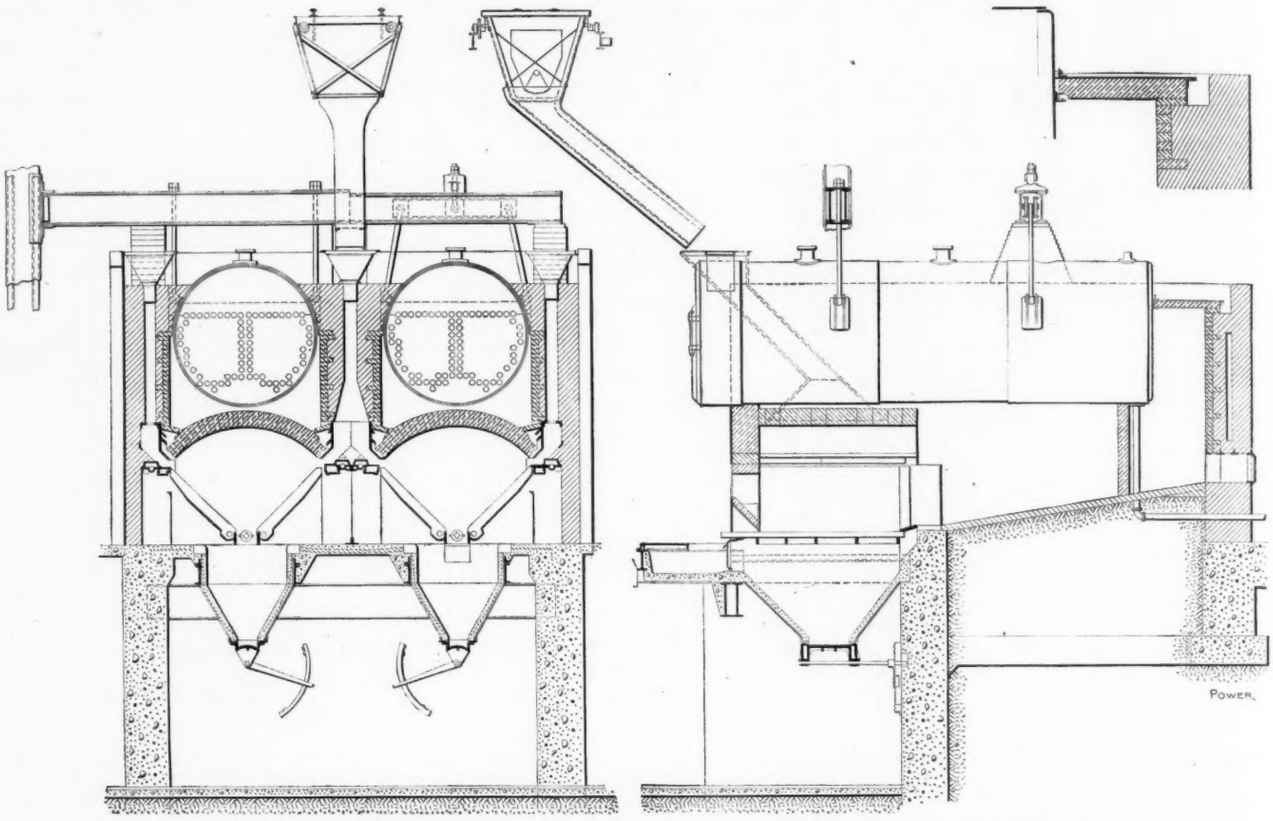


FIG. 3. ILLUSTRATING THREE-POINT SUSPENSION AND SPECIAL BACK-ARCH CONSTRUCTION

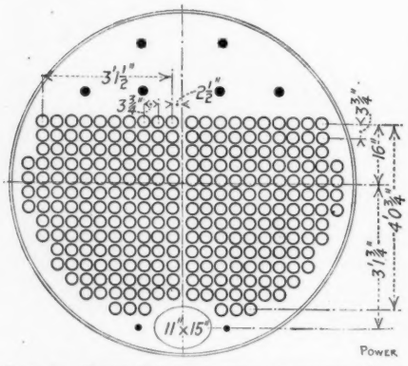


FIG. 5. TUBE LAYOUT FOR 90-INCH HORIZONTAL TUBULAR BOILER

It is my practice to suspend the boilers from above, and I prefer Mr. Woolson's three-point suspension. This and the setting for the Diamond State Fiber Company are shown in Fig. 3.

VERTICAL BOILERS

Many vertical fire-tube boilers have been built having the diameter of the outside shell reduced above the crown sheet by a reversed flanged connection, often called an "ogee." Many of these flanges have cracked circumferentially on account of bellows action caused by changes in pressure and by vertical vibration caused by the opening and closing of the inlet valves of steam engines. An examination of such boilers will often show a vibration coinciding with the revolutions of the engine. It can be said, in fact, that this is the only kind of boiler that breaks in two. The defect has been diminished by making the reversed flange thicker and less flat, and thus reducing the action that has been, by some, thought important in vertical boilers for permitting free expansion of the tubes.

The recent explosion of such a boiler at the Amoskeag mills and the action of the reversed flange in an experimental boiler recently tested to destruction, should serve to open people's eyes to the unsuitability of such a design, especially for high pressures. Such boilers are unquestionably dangerous because they elongate seriously under pressure, make the upper tube plate convex downward, the lower tube plate convex upward and tend to pull the outer tubes out. This is what occurred in the exploded boiler, and although the tubes of that boiler were not beaded, the additional safety caused by beading must make a very narrow margin between safety and danger. The reversed flange can be replaced by a long conical course which will not yield, and which will give whatever advantage is accomplished by a reduction in diameter. Many such boilers have been built and one is shown in Fig. 4.

QUANTITY OF HEATING SURFACE

It is a custom of boilermakers to make too little of the opportunity of getting a great deal of heating surface in horizontal return-tubular boilers. By so doing they make a boiler plant unnecessarily large and expensive.

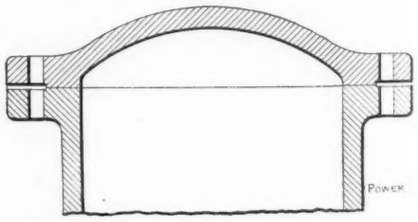


FIG. 6. PREFERRED DESIGN FOR BLANK FLANGE

Boilers can have tubes as follows with no resulting disadvantage and with important gains in horsepower and saving of room:

72″ boiler, 140–3″ tubes, 2033 sq.ft. h.s. (18′ tubes)
78″ boiler, 166–3″ tubes, 2376 sq.ft. h.s. (18′ tubes)
84″ boiler, 192–3″ tubes, 3056 sq.ft. h.s. (20′ tubes)
90″ boiler, 260–3″ tubes, 4016 sq.ft. h.s. (18′ tubes)

In the last case (90-inch boiler) the tubes are ¾ inch apart, and very high. These boilers are rated each at 400 horsepower and when run at nearly 800 horsepower they send over dry steam and cause no trouble. There is no reason for being afraid of putting much more heating surface in boilers of this type than is common.

Large Units

There is likewise fear on the part of many persons of making large fire-tube boilers. It has been conclusively shown by several installations that 400-horsepower horizontal return-tubular, and 500-horsepower vertical boilers are satisfactory, and either can be run at double or more their usual rating. There is no limit to the sizes of these types except shipping possibilities. In a large plant there are great advantages in large units as follows:

Smaller number of boilers; smaller number of pipes and valves; smaller buildings; smaller number of men required; greater economy by reduction of losses; less number of chances for explosions and troubles; reduced cost of plants.

These facts are becoming recognized and will be taken advantage of more and more.

For the arrangement of tubes in a 90-inch boiler see Fig. 5.

Factor of Safety

The factor of safety in boiler shells is of less importance than is generally supposed. In 1908 the Massachusetts Board of Boiler Rules increased the factor of safety from 4½ to 5. In my opinion this is a mistake, for boilers never explode because the shell is too thin. Explosions are due to cracking of plates due to causes which do not come from thinness, and it is probable that increasing the thickness intensifies these causes.

Elastic Limit

Some engineers base the factor of safety of boilers upon the elastic limit of the material, and this is the logical way. The value of the strength of a plate lies between zero and the elastic limit, and the difference between the elastic limit and the ultimate strength is so much lumber. It is common to say that the elastic limit of steel plate of boilers shall be not less than one-half of the ultimate strength. If it is one-half, the factor of safety with reference to it is 2½ if it is 5 referred to the ultimate strength. If it can be 2½ referred to one elastic limit, it can be to another, and this clearly establishes the propriety of this principle. Steel can be made by anybody with a high elastic limit and a low ultimate strength, accompanied with all desirable properties. Such steel is very desirable because it will make a strong, thin, light, cheap and more durable boiler than that customarily used. It will be more durable because it is less likely to crack either in making or operating. If I were not prevented by established legal rules I should specify boiler plate to have an elastic limit between 35,000 and 40,000 pounds and an ultimate strength as low as possible, say about 50,000 pounds per square inch.

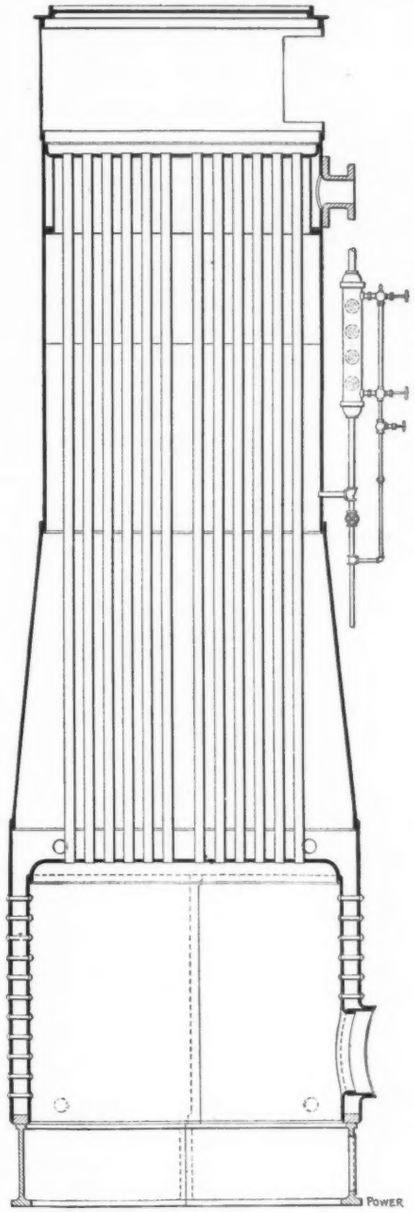


Fig. 4. Vertical Boiler of 175 Horsepower Capacity

Blank Flanges on Pipes

The recent explosion of a blank flange on the end of a large steam pipe at the Amoskeag mills should cause steam engineers to require that these flanges should always be not only very heavy, but made spherical in form inside of the bolt circle. If they are not they are weak unless they are very thick. If they are flat and ribbed they are worse than if they had no ribs, when the ribs are outside, and the ribs are of little value when they are inside. If they are spherical, ribs should not be used. The extra cost of a spherical blank flange is trifling. See Fig. 6.

Smokestacks for Natural Draft

By M. E. Harris

To solve the problem of correct dimensions for a proposed stack it is first necessary to approximate as closely as possible the capacity of the plant based on the commercial evaporation. Then if there is the least probability of any increase in the demand for power, make proper allowance for such increase and do not be afraid to err a little in favor of bigness.

After the horsepower capacity of the plant has been determined a simple and easily remembered rule for proportioning the stack is to multiply the number of horsepower by 6. This will give the area of the stack in square inches. Thus, a 500-horsepower plant requires a chimney with an area of 3000 square inches. This would equal a circular stack of about 62 inches diameter. A comparison with stacks already built will show that this figure is approximately correct.

The hight of a chimney is sometimes governed by local conditions, such as the hight of the building to which it is attached or the hight of surrounding buildings. The ratio of hight to diameter may be from 20 to 36 diameters of a circular stack or lengths of one side of a square stack.

One rule establishes the hight of the stack at 25 diameters. This would be correct for some sizes, but would not apply to all. The hight of the larger chimneys must be limited to keep down the cost of construction, and the hight of smaller stacks must be sufficient to give draft enough to maintain the desired rate of combustion. Thus an 8-foot stack multiplied by 20 gives 160 as the proper hight, and a 2-foot chimney multiplied by 36 gives 72 feet as the hight.

Stability or resistance to wind pressure is secured by constructing the base with an outside diameter equal to one-tenth of the hight.

Corrosion is generally due to air which has been absorbed by the feed water and which cannot be removed. Its action is intensified by common salt and by chlorides of magnesia and lime; its action is diminished by suitable additions of soda and of lime. Purified water, in addition to obviating scale, also reduces corrosion. Excesses of soda or boiler compositions attack brass fittings and cause leaky seams.—*Ex.*

Oil Fuel for Steam Boilers*

By B. R. T. Collins

The possibilities of oil fuel along the Atlantic coast; its advantages and disadvantages and the principles involved in the efficient burning of fuel oil.

*From an address before the Boston section of the American Society of Mechanical Engineers, on April 21. Mr. Collins has been engaged in the burning of oil fuel for the past 17 years.

In view of the present gradually increasing cost of coal for steam-generating purposes in the Atlantic coast States and especially in New England, the question of a satisfactory and economical substitute naturally arises. Among various possible substitutes crude petroleum and its residual product, commonly known as fuel oil, have attracted more or less attention since the discovery of the Texas oilfields about ten years ago.

Fuel oil is more satisfactory for burning than crude petroleum because practically all of the light and easily ignited products, such as naphtha, gasolene and kerosene, together with any water which the crude oil may contain, have been removed by a process of partial distillation. Hence, while the crude oil is burned in large quantities in the Gulf States and along the Pacific coast with safety under proper precautions, fuel oil, which has a considerably higher flash point and calorific value, can be used for fuel by men of ordinary intelligence with practically the same safety as coal.

The cost of fuel oil in the New England States has been decreasing recently so that at the present time it can be purchased there more cheaply than in the western part of Texas. This is due to the fact that the cost of transporting oil in tank cars to western Texas is greater per barrel than the cost of transporting it to New England in barges and tank steamers.

At present the major portion of the supply of oil for fuel purposes for the north Atlantic States comes from Texas, Louisiana, Oklahoma and Kansas, this group of States producing about 62,000,000 barrels in 1909, or over one-third of the total production of petroleum for the United States in that year, in spite of the fact that California made an increase of over 20 per cent. above her production of petroleum for 1908. During the year 1910 there was an increase to 72,000,000 barrels in the production of crude oil in the States mentioned, as well as a phenomenal increase of 50 per cent. to 77,000,000 barrels in California, thus making the total production for the United States 216,500,000 barrels, or about two-thirds of the total production of crude petroleum for the world. The increase in the production from 1898 to 1910 is shown in the chart.

The interest that fuel users along the Atlantic coast have in California oil may seem at first to be very small, but with the opening of the Panama canal now promised for 1915, a means will be provided for the easy and cheap transportation of California's surplus production to Atlantic coast ports. Furthermore, the strip of country between the mountain ranges and the Pacific ocean in Mexico, Ecuador, Peru and Chile is known to be rich in petroleum, and with the completion of the canal all of this region as far south as Valparaiso, Chile, will be brought nearer to the Atlantic seaboard than the port of Los Angeles, Cal.

It is understood, of course, that the supply of fuel oil at the present time would take care of only a small portion of existing steam plants now using coal, but judging from the fact that the production of crude petroleum in this country increased over threefold during the last ten years, there should be sufficient fuel oil to take care of a gradually increasing class of plants which for various reasons and conditions can use it economically. Included in this class would be:

1. Plants where the cost of handling coal by hand is higher than the average because of local conditions, and where the installation of suitable coal-handling equipment would not be warranted by the saving effected.

2. Plants in which the boilers are fired by hand and more than one fireman is required on each shift.

3. Plants where greater capacity is required than can be obtained with the coal available. With oil, 35 per cent. or more additional capacity can be obtained than with high-grade coal.

4. Plants where the boiler capacity is limited by the capacity of the existing stack or stacks and where it is not desired to install more stack capacity, although more boiler capacity must be obtained. Oil fuel can give this added boiler capacity without increasing the stack capacity, as the stack area required for the same boiler capacity with oil is only about 60 per cent. of that required for coal.

5. Plants where it is necessary to keep smoke below certain fixed limits at all times, due to smoke ordinances.

Oil Analyses

The accompanying table shows comparisons between the calorific value and other properties of crude oil, fuel oil and coal.

Advantages and Disadvantages of Oil Fuel

The advantages of oil fuel may be summarized as follows:

1. Calorific value per pound 30 per cent. higher than that of high-grade coal, less weight of oil being required to give the same heating effect.

2. Space required for storage of oil is less than that for an equal weight of coal.

3. Oil does not deteriorate by storage, as coal does to a greater or less degree.

4. Lower temperature in boiler room.

5. Area of stack 60 per cent. of that required for coal for equal boiler capacity, thus enabling a plant having insufficient draft with coal to have an excess amount with oil, a change from coal to oil making the installation of additional stack capacity unnecessary.

6. Less heat lost up the stack, owing to cleaner condition of tubes and to smaller amount of air which has to pass through furnace for a given calorific capacity of fuel.

7. Higher efficiency due to more perfect combustion with less excess air, more equal distribution of heat in combustion chamber, as doors do not have to be opened and very little soot is deposited on the tubes.

8. Increase in capacity over coal.

9. Heat is easier on the metal surfaces, being better diffused over the entire heating surface of the boiler.

10. Ease with which fire can be regulated from a low to a most intense heat in a short time or entirely extinguished

COMPARISON OF PROPERTIES OF CRUDE OIL AND FUEL OIL

Oil	Field	Carbon, Per Cent.	Hydrogen, Per Cent.	Sulphur, Per Cent.	Oxygen, Per Cent.	Specific Gravity	Flash, Degrees F.	Fire, Degrees F.	B.t.u.	Authority
Crude	Sour Lake, Tex..	....	....	...	...	0.9266	198	...	18,460	Professor Scott, University of Texas
Crude	Beaumont, Tex...	....	....	...	....	0.9179	...	...	18,500	
Crude	Beaumont, Tex...	84.6	10.9	1.63	2.87	0.9240	180	200	19,060	U. S. Naval Liquid Fuel Board
Fuel	Beaumont, Tex...	83.3	12.4	0.50	3.83	0.9260	216	240	19,481	
Crude	Whittier, Cal....	....	....	....	....	0.9416	...	...	18,513	Professor Blasdale, University of California

instantly in case of emergency, such as water dropping out of sight in gage glass, and quickly relighted when the emergency is over. In less than half an hour a boiler can be brought up to 150 pounds steam pressure from cold water, if necessary.

11. Smoke can be entirely eliminated.
12. No cleaning of fires.
13. Much lower cost for handling oil than handling coal.
14. Absence of coal dust and ashes.
15. No firing tools used, consequently, no damage to furnace linings from this source. No clinkers to be removed from grate bars or furnace side walls.
16. Saving in labor of all kinds.

The disadvantages of oil fuel are:

1. Low flash point. Fuel oil should have a flash point not lower than 140 degrees Fahrenheit, and with oil of this quality, handled by men of ordinary intelligence and common sense, there is practically no more danger than with coal.

2. The ordinary underwriters' or city requirements specify that storage tanks for fuel oil be located underground and at least 30 feet from the nearest building. This can generally be complied with in the case of the power plant of the average manufacturing concern, but in the case of a plant in the congested districts of a city it is likely to be prohibitive.

3. With boilers using feed water of considerable scale-making qualities, the cost of repairs is likely to be increased by changing to oil, owing to the intense temperature developed in the furnace.

Principles Involved in Efficient Oil Burning

The requirements for the perfect combustion of liquid fuel are as follows: Reduction to a fine spray or complete atomization; bringing it into contact with the proper amount of air; mixture of oil spray and air burned in the furnace of refractory material with room enough to complete combustion before the gases come in contact with the boiler-heating surfaces. The first condition is fulfilled by selecting a proper burner, and the remaining conditions can generally be obtained by making slight changes in, or additions to, the existing furnaces.

As to whether steam or air should be used for atomizing the oil, the decision is usually in favor of steam, because it takes about the same amount of steam to operate the air compressor as it does to atomize the oil at the burner and the additional investment and complication involved with greater possibility of interrupted service is avoided.

Also a flat fan-shaped flame presents a larger surface for heat radiation and uniform distribution of gases than any other shaped flame, and at the same time requires a minimum number of burners per boiler.

Heating of the oil is an aid to economical combustion, and should take place as near the furnace as possible and be carried as high as safety permits, but not so high as to cause the oil to decompose and carbon to be deposited in the supply pipes. If preliminary heating is limited to the temperature of the flash point of the oil used there can be no trouble from these causes.

One of the most important questions in the combustion of liquid fuel is the regulation of the air supply in such a way as to obtain perfect combustion before the gases come in contact with the heating surfaces of the boiler. This can be done with an automatic damper regulator, although its adjustment is rather difficult. It is therefore usually accomplished by hand regulation of the damper when considerable variations in the load take place. This is supplemented by changing the position of the ashpit doors, which are kept closed until a slight tendency to make smoke is noticed in the furnace; or, better, by using an Orsat or continuous CO_2 recorder to determine the position of the damper and the ashpit doors which give most complete combustion under certain constantly recurring conditions.

Types of Oil Burners

Although thousands of patents have been granted for oil burners or atomizers two general subdivisions or five general classes, as designated by the United States Naval Liquid Fuel Board, cover practically all of the main features of construction. The two general subdivisions are:

Outside mixing: Oil and atomizing agent meet outside the burner.

Inside mixing: Oil and atomizing agent meet inside the burner.

The five general classes included are:

Drooling: Oil oozes out onto the steam or air jet.

Atomizing: Oil is swept from the orifice by steam or air jet.

Chamber: Oil mingles with steam or air in the body of the burner and the mixture issuing from the nozzle is broken into minute particles by the expansion of the steam.

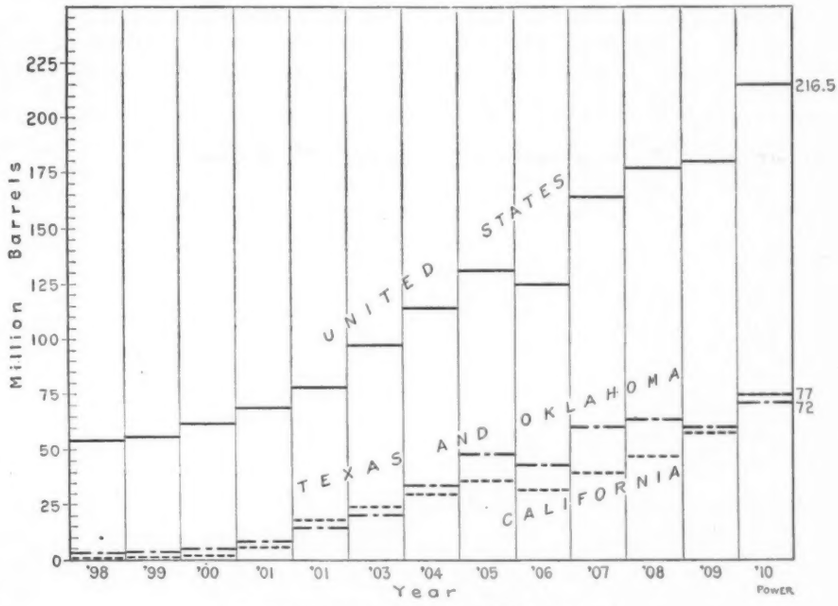
Injector: Similar in principle to boiler-feeding injector.

Mechanical spraying: Effected by mechanical means without the use of atomizing agents, such as steam or compressed air.

Method of Installation

In spite of the various principles involved in burner construction, the success of an oil-fuel installation depends not so much upon the type of burner or atomizer used as upon the method of its installation, and the intelligence with which it is operated after the installation is made.

To conform with the underwriters' requirements, storage tanks above the surface of the ground should be placed at least 200 feet from inflammable property, and the top of the tanks should be located below the level of the lowest pipe used in connection with the apparatus. When the tanks are located underground, they should be outside the building, at least two feet below the surface and 30 feet from any building, with the top of the tanks below the lowest pipe in the building used in connection with the apparatus. Storage tanks should be fitted with vent pipes, indicators showing the level of oil in the tanks, filling pipes, arrangements for freeing the tanks from



Production of Oil from 1898 to 1910

water, suction pipes, return or overflow pipes, steam pipes for filling the space in the tanks above oil with steam in case of fire, and suitable manholes for cleaning-out purposes. A suitable strainer should be installed on the suction line between the storage tanks and the oil-pressure pumps. The suction line should slope so that it will drain all oil back to the storage tanks when the pump is stopped and a vent opened. Duplicate oil-pressure pumps should be installed with pump governors and all piping in connection with these pumps should be cross-connected in such a manner that a change can be made from one to the other and repairs made to either without interrupting the service. A suitable oil heater should be installed, so that the exhaust steam from the oil pumps can be utilized to heat the oil before it reaches the burners. A relief valve should also be installed on the discharge line between the pumps and the burners, and provision should be made for removing any condensation from the steam lines to the burners. Automatic regulating devices are desirable for varying the pressure of both the oil and the steam to the burners in accordance with the demand for steam on the boilers.

In a series of tests* on a 604-horsepower Babcock & Wilcox boiler equipped with Hammel burners and furnaces at the Redondo plant of the Pacific Light and Power Company, an efficiency as high as 83.3 per cent. was obtained, and the water evaporated per pound of oil from and at 212 degrees Fahrenheit was 15.81 pounds. The average percentage of CO_2 was 13.2, the excess air 21.2 per cent. and the steam used by the burners 2.15 per cent. The average efficiency for all seven tests, running from 72.7 per cent. up to 195.5 per cent. of rating, was 80.47 per cent., and the average evaporation from and at 212 degrees Fahrenheit was 15.23 pounds.

In tests made at the Ravenswood plant of the New Amsterdam Gas Company, on a 595-horsepower Babcock & Wilcox boiler, equipped with a Peabody furnace and four No. 1 burners, a boiler efficiency of 80.97 was attained, when evaporating 14.61 pounds of water from and at 212 degrees Fahrenheit per pound of oil. The steam used by the burners was 1.54 per cent. of the total steam generated.

Although a fair idea may be obtained of the comparative cost of the two fuels by making certain assumptions in regard to heat values, specific gravity, gain in efficiency, etc., still this will not enable one to figure the saving which could be made by changing from one fuel to the other. The reason for this is that the saving generally depends on other things than the cost of the fuel. The saving in firemen and coal passers, increase in capacity, facilities for fuel storage, advantage of pumping oil over methods of handling coal, elimination of handling ashes, quantity of coal used for banking fires, elimination of smoke and other things, many of which cannot be figured out in advance in dollars and cents, would throw the ultimate cost decidedly in favor of oil. The only way to determine the exact saving is to operate the plant with each fuel for a long enough period to get accurate data on all the items entering into the question.

*The results of these tests are given in the May 9 issue of POWER.

DISCUSSION

D. S. Jacobus: The efficiency results secured in the tests on an oil-burning boiler at Redondo, Cal., represent good practice. Better results, however, than these were secured in tests made on one of the boilers at the same plant preparatory to making a test of the plant. The results of the plant tests, which have already been reported to the society, indicated that a kilowatt-hour was turned out at the switchboard for every 25,000 B.t.u. contained in the fuel oil. In these tests the standard form of Peabody furnace was employed with burners of the outside-mixer type. I intend to submit the results of the tests of the single boiler to the society in connection with an article dealing with boiler and furnace efficiencies.

M. H. Bronsdon: Every test of crude or fuel oil made for me by Professor O'Neill at the University of California showed practically the same calorific value, regardless of its specific gravity or whether or not the gasolene had been removed. The more fluid oils are much less troublesome, requiring much lower pressure to send them through the piping and where the gravity is 17 degrees Baumé or lighter at 60 degrees Fahrenheit they require no warming during the pumping process.

Where oil is used for fuel, perfect combustion may be obtained under all conditions of load with proper installation excepting when the fires are first lighted and the brickwork is comparatively cold. The labor charge is much lower with oil fuel than hand-fired coal, for with oil fuel one fireman can readily care for the fires under 5000 or more horsepower of boilers, provided the boilers are on the same floor level and equipped with feed-water controllers.

Boiler settings and boiler tubes will last much longer with oil than with coal, provided the tubes are kept clean. The flame from the burners should not under any circumstances be allowed to impinge upon the boiler tubes. Extra large combustion chambers below the tubes are especially desirable.

The impression should not be given that by changing from coal to oil fuel the capacity of any boiler plant can be increased from 35 to 50 per cent. In a boiler plant with sufficient draft to burn large quantities of coal, or where the evaporation can be made to exceed, say, seven pounds of water per square foot of heating surface, fuel oil will not increase the capacity 35 to 50 per cent.

Every item and condition of boiler-plant operation favors the use of oil fuel, the price of the oil being the only factor regulating the economical results to be obtained. Its use is clean, safe, reliable and responsive, the only laborious work being that of changing and cleaning the burners and piping. Proper cleaning vats should be provided in a suitable place, as fuel oil is very sticky and odorous.

Experience leads me to favor burners of the type known as "outside mixers," that is, where the oil and steam mix just beyond the tip of the burner. Carbon seldom causes trouble with burners of this type, even where the oil is quite hot before it reaches the burner. There seems to be no practical difference in the efficiency, however, in the use of either "inside-" or "outside-mixer" burners.

When properly installed, there is no danger from storing or using oil fuel. One important requirement is that the tank should be well ventilated to allow the escape of any gas that forms and no flame should be allowed to approach the uncovered storage tank.

In a well designed and carefully operated boiler plant using coal for fuel, where the efficiency is approximately 75 per cent. or better, the use of fuel oil will not change the efficiency materially. In a plant which operates from 20 to 24 hours per day, the standby losses, of course, will be lower with oil than with coal for fuel, due to the fact that there are no banked fires to be maintained under spare boilers, some of which are of use only during the peak-load conditions. Any gain in efficiency is not due simply to the use of oil fuel instead of coal, but rather to better conditions which are maintained with less effort on the part of the operatives, such as the removal of soot from the tubes, cleaner back connections and the fact that the fireman is not fatigued by his labors, but can without any particular effort see that perfect combustion is maintained. The CO_2 recorder becomes a valuable instrument in a boiler room using oil for fuel.

Professor Robinson: It would seem to me that the place where the use of fuel oil would have its greatest economic advantage, would be on steam vessels. There the saving in weight, volume and labor would have a much greater value than on shore. This would make it possible for the steamships to pay a higher price for oil than installations on land. Such being the case, it would seem to have small chance to compete with coal in New England until such time as it shall have been demonstrated that the

supply is sufficient to take care of the steamships and leave a surplus for the land plants.

R. C. Monteagle: The question was asked whether there were any vessels running in New England that were burning oil. I do not know of any at present. The "Harvard" and "Yale" were two good examples; they are now on the Pacific coast. When they came out first they were fitted to burn coal and the running time between Boston and New York was 15 or 16 hours, and they almost invariably took over that time. After running a year they changed over to oil fuel, and thereafter had no trouble in making the trip on running time. I was going to ask Mr. Collins if he could not get some more data about the amount of water in fuel oil, as I understand all fuel oil contains a certain percentage of water. In the case of one of the vessels referred to, I happen to know that due to water in the oil, in one particular instance, it caused the flame to go out, and as the fireman did not go the rounds properly, the oil kept flowing into the corrugated furnace and overflowed under the fire-room floor. When he finally discovered that the flame was out he stuck a torch into the furnace and immediately there was a puff and fire. If the vessel had not been built of steel it might have been a total loss.

In reply to several individual questions, Mr. Collins stated that the steam required for the oil pumps was about 1.5 per cent. of the total steam generated; this added to that required for atomizing made a little over 3 per cent. As to the presence of water, this is very apt to be present in crude oil, but fuel oil should be free from it. Furthermore, if two or more burners are used, and a slug of water extinguishes the flame in one, the flame from the other will relight it. Referring to the case cited by Mr. Monteagle, Mr. Collins pointed this out as proof that only reliable men should be employed in fire room when oil is used as fuel.

Some Ingenious Engine Room Kinks

By R. O. Warren

Most power plants contain interesting features, some of which would escape the casual glance because their simplicity detracts from their real merit. During a recent visit to the power plants of the Amoskeag mills, Manchester, N. H., the writer saw several devices which were of interest.

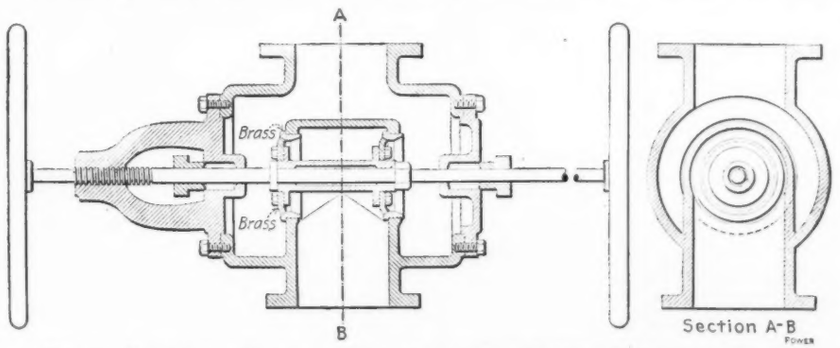


FIG. 1. SECTIONAL VIEWS OF DOUBLE-WHEEL-AND-STEM THROTTLE VALVE

Perhaps one of the most important was a double-stem, double-wheel poppet throttle valve, one of which is used on each reciprocating engine throughout the works. A sectional view of one of these valves is shown in Fig. 1. It consists of the main body containing two double brass seats against which the double poppet-valve disks seat. In addition to this feature the valve stem is made with an extension, as shown. This valve stem passes through the sleeve to which the brass valve disks are secured, each by four ⅝-inch tap bolts. One end of the sleeve fits against a collar on the valve stem; the other faces against a nut. Both ends of the valve stem pass through a stuffing box, but only one end of the stem is threaded.

The chief advantage of this valve is that the engineer can shut down the engine from either side of the cylinder, a most convenient arrangement in case of a runaway engine. Fig. 2 shows one of these valves in the steam pipe of one of the large reciprocating engines. This illustration also shows an arrangement used to prevent pipe vibration. Before this device had been put in place the pipe vibration was so severe that leakage continually occurred at the joint formed at the straightway valve shown in the vertical pipe.

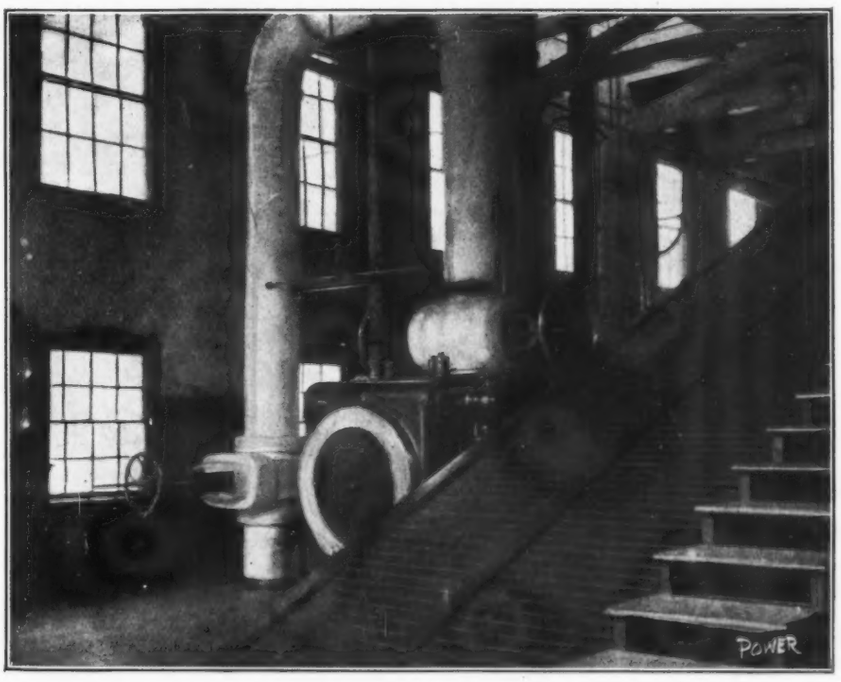


FIG. 2. DOUBLE THROTTLE VALVE AND PIPE BRACE

Details of the arrangement are shown in Fig. 3. It consists of two saddles, each fitting on each section of vertical pipe, and a distance piece which snugly fits into the hollow place in each saddle. The saddles and distance piece are kept in place by means of two stayrods which are drawn together by two turnbuckles. Each rod is bent around the pipe as shown; the turnbuckles are midway between the two vertical pipes.

While passing an almost empty coal-storage bin, a method of ventilating the coal was observed, which is illustrated in Fig. 4. The bin contains several rows of upright beams, as shown. On two sides of each upright there are fitted saw-teeth projections, each projection

forming an air space leading to the main flue, which extends from the bottom to the top of the upright supports.

When the storage bin is full of fuel, the gases and heat generated will escape through the numerous air vents to the top of the building. In this manner spontaneous combustion is prevented to a certain extent. There is one disadvantage; if the coal should once get on fire the ventilating vents would produce an excellent draft and add to the difficulty in subduing the fire.

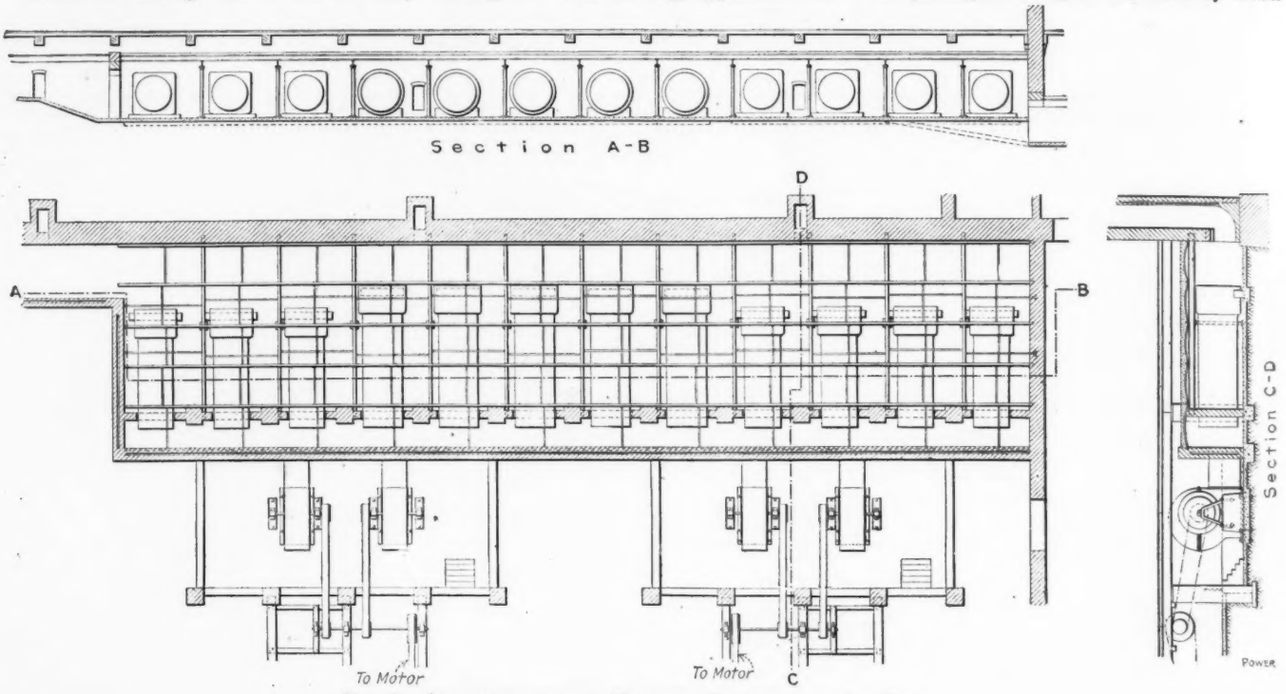


FIG. 5. ARRANGEMENT OF HEATING BOILERS AND AIR FANS

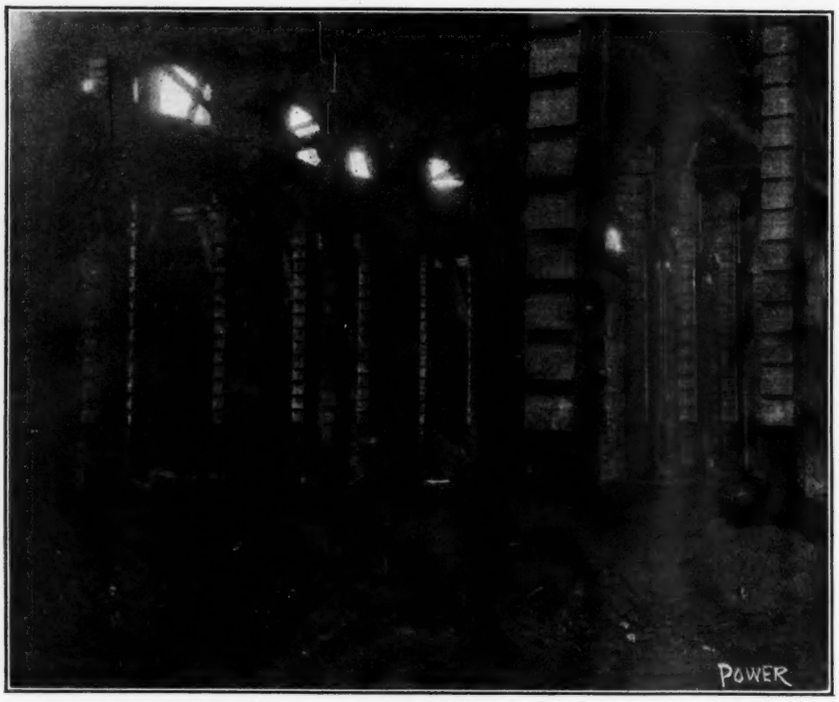


FIG. 4. SHOWING CONSTRUCTION OF VENTILATING CHUTES

An interesting method of heating and ventilating the Coolidge mill, the latest addition to the Amoskeag mills, is shown in Fig. 5. The heating apparatus consists of seven old Manning boilers, each 5 feet in diameter and 16 feet 6 inches long, and five larger boilers of the same make, each 6 feet 6⅜ inches in diameter and 19 feet 5½ inches long. These boilers are all placed in a horizontal position and rest on brick piers placed at each end of each boiler. Exhaust steam is carried through a tunnel from an adjacent mill to these boilers, and surrounds the tubes on the outside. The boilers are separated at the end next to the air passage leading to the fans by brick headers, so that the air cannot bypass between the boilers.

Extending along the front end of the boiler is an air duct which is 8 feet 10 inches high and 4 feet wide. At the rear end of the boiler, connection is made with an air duct which is 5 feet high and 40 inches wide. This air duct runs up to the Coolidge mill, in the basement of which the hot room is located. Another branch leads to a neighboring mill. Two 6-foot fans, placed outside of the wall surrounding the boiler, supply the air for heating and ventilating; each is driven by a 60-horsepower motor. These fans force the air into the air duct at the front end of the boiler and the air passes through the boiler tubes to the other end, where it is allowed to surround the outside shell of the boilers, thus coming in contact with every part of the heating surface of the boiler shell and tubes. The air when thoroughly heated passes to the various rooms in the mills.

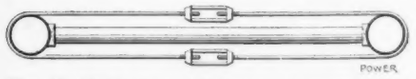


FIG. 3. DETAILS OF SADDLES AND STAYROD ARRANGEMENT

By means of this system two large mills are heated indirectly by exhaust steam with very little piping and no radiators. The help that would be necessary to keep them in proper condition is therefore eliminated.

These devices have been put in under the direction of Charles H. Manning, mechanical engineer of the company.

Electrical Department

Especially conducted to be of interest and service to the men in charge of the electrical equipment

Automatic Starting Attachment for an Exciter

An exciter unit that is somewhat out of the ordinary is in operation in the power plant of the Lynn Gas and Electric Company at Lynn, Mass. The unit consists of a 125-volt General Electric dynamo of 75 kilowatts capacity driven by a Curtis turbine at a speed of 2400 revolutions per minute; the steam pressure is 150 pounds per square inch. The special feature of the outfit is an arrangement for starting the unit automatically when the running exciters reach their load limit.

A general view of this unit is shown in Fig. 1. The constructional details of the automatic attachment are shown in Fig. 2; this is a steam-control valve consisting chiefly of a Waters governor with the springs, ball weights, pulleys and gears removed, the only part utilized being the valve body, valve and stem. The valve is inserted in the steam-pipe line upside down and is fitted with a bypass

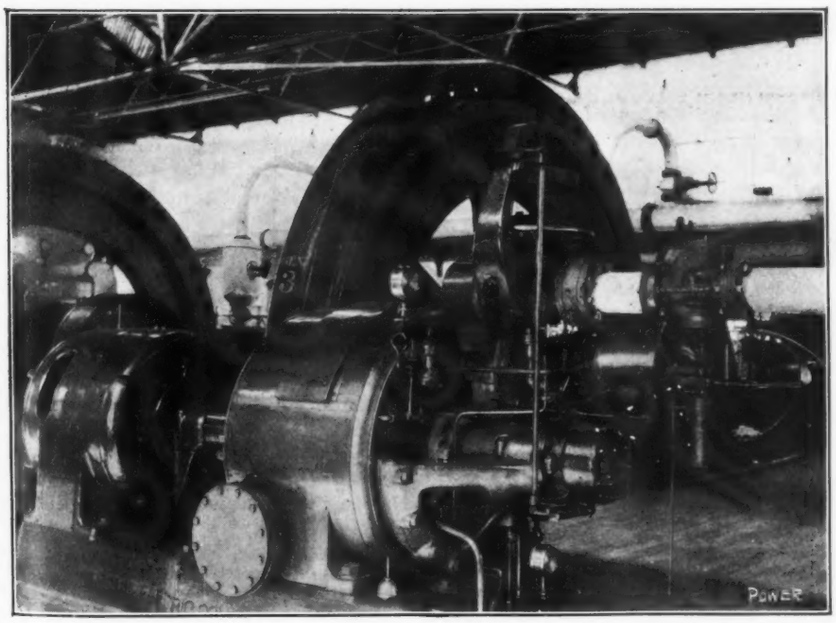


FIG. 1. EXCITER UNIT WITH AUTOMATIC CONTROL

adjusted so that when the main valve is closed a small volume of steam flows through the bypass to the intake end of the turbine; the condensed steam is permitted to drain from the turbine casing through the drip valves, which are always open. This arrangement keeps the steam end of the turbine hot and ready for immediate use. Bolted to the flange of the control-valve body is an L-shaped piece of flat iron *A*, to which a thin piece of wood is attached and this supports an electromagnet *U*, which is energized from the exciter busbars on the switchboard. Attached to the member of the governor which contains the bearing through which the valve stem passes is a U-shaped piece of iron to which the lever *L* is pivoted at *M*. A slot *N* is cut in the lever in which the pin *O* can slide; this pin passes through the valve stem.

A piece of soft steel of the same width as the magnet core and forming an armature for the magnet is attached to the handle, as shown at *P*, and a 28-pound lead weight *Q* is hung on the end of the valve stem. So long as current at the normal pressure of 125 volts passes through the magnet coil, the magnet holds the lever *L* in the position shown, in which position the valve is closed and the turbine inoperative. When the exciter voltage drops seven volts, a relay opens the circuit through the magnet coil and the magnet, being deënergized, is, of course, unable to hold the lever up against the downward pull of the weight *Q;* the latter drops, pulling the lever down and opening the valve, thereby starting the turbine. Too rapid descent of the valve stem is prevented by means

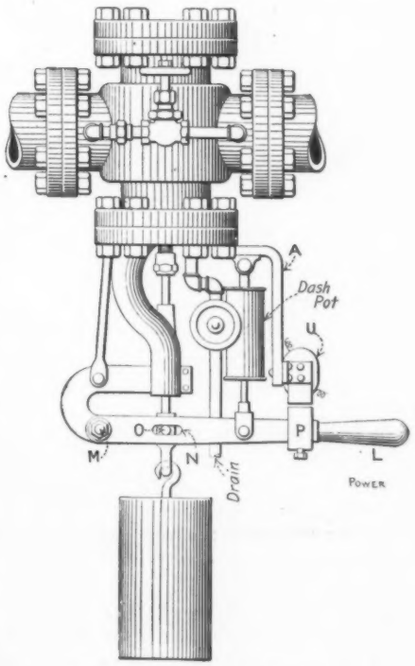


FIG. 2. AUTOMATIC STARTER

of the dashpot shown in the sketch. The handle *L* is for closing the control valve, of course, when the turbine is to be shut down.

Fig. 3 is a diagram of the master circuit in which the magnet *U* is the one shown in Fig. 2. Normally, when the exciter is not needed, the switch *T* is held closed by the solenoid *S* which is also energized from the exciter busbars. A drop of seven volts weakens the solenoid to such an extent that its plunger drops and opens the switch *T*, thereby "killing" the magnet *U* which has been holding the steam valve of the turbine closed, as described.

The switch *V* has three blades but the middle one is independent of the other two when they are closed. When the handle is pulled, however, it opens all three contacts. The middle blade, when closed, short-circuits the resistor *R* and this strengthens the solenoid *S* sufficiently to enable it to lift its plunger and close the switch *T*. When this has been

accomplished, the middle blade is pulled out, leaving the resistor *R* in series with the solenoid *S*, in which condition the latter will just hold up its plunger at normal exciter voltage. The middle blade

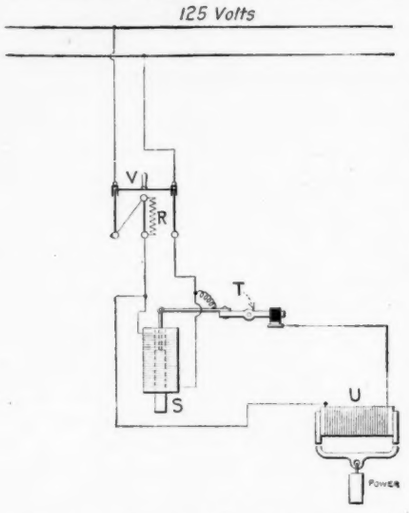


FIG. 3. MASTER CIRCUIT DIAGRAM

of the switch *V*, therefore, serves merely to reset the switch *T* from the switchboard.

An East Indian Postgraduate Technical School

Mr. Tata's Research Institute in Mysore has at last been completed and will begin work next July. Dr. Morris Travers, director of the institute, has issued the following statement:

"The annual guaranteed income of the institute is about 270,000 rupees (about $86,000) which sum should be able to maintain six departments of work. The work at the beginning, however, will be limited to four departments, namely, general, organic and applied chemistry, and electrical technology, these being considered by the council to be of the greatest importance to Indian arts and industries and not provided for in the other post-graduate institutions in the country. Graduates of a recognized university or a similar institution will be admitted as students. The institute does not charge any fees for tuition, though it does not offer any scholarships. The council has decided that the other two departments are to be devoted to pure and applied science, in some branch, but is not in a position to make a definite announcement on this subject."

The institute owes its existence and its magnitude to the princely donation of Mr. Tata and the generosity of the Mysore state. The work has taken about ten years. It aims to provide an institution where technical and scientific research work of a higher order can be undertaken on a large scale in its laboratories and where the students can have a practical insight into such work.

Small Station Switchboards

BY GUION THOMPSON

It is almost universal practice in small plants to display as much switchboard as circumstances render possible. The switchboards are bulky and by some are considered unsightly; also more of a plaything than a necessity. The wiring and apparatus are usually crowded in a mass on the back in order to avoid getting the board too large from the point of view of switchboard advocates. To those who do not admire them, this mass of wiring and apparatus appears inconsistent with the form of energy being handled and seems a departure from the usual rules of spacing and other precautionary methods practised in other branches of the art. The appearance of a generator room is better without a switchboard, as has been demonstrated in the large stations where the boards are placed on galleries. The largest and latest stations are working toward elimination altogether, which appears to be much more in keeping with thorough station efficiency.

The switchboard is only a development of our old-fashioned admiration of mechanism to be manipulated and with which to awe the uninitiated. The apparatus mounted on a switchboard is refined down to the last notch of size and delicacy, all of which tends to detract from its efficiency, as of all the parts of a station equipment the control should be rugged and reliable to the highest degree. A remote-control board may appear complicated, but it is based on simple principles the applications of which do not need to be shaved down to the last degree of delicate construction in order to reduce space and attain convenience. The switch gear and main circuit connections are rugged and of open construction, easily accessible and yet removed from accidental interference by reason of their isolated situation.

The expense of remote-control equipment is considered excessive in small plants but there is no reason why it should cost more than the ordinary switchboard in any station that contains more than a small generator circuit-breaker, switch and voltmeter. For example, in a small plant of two 500-kilowatt water-driven three-phase generators with six outgoing feeders and requiring one attendant on watch, the generator room should contain only the generators, exciters, wheel governors and attendant's desk. The desk should be so placed that while sitting thereat the attendant has full view of the room. The required generator and feeder indicating instruments should be mounted on a small panel along the back of the desk about eight or ten inches high and on the top of the desk, with a clear space in the center, should be the finger switches controlling the main switch gear in the basement, wire tower or other protected location, as conditions may indicate.

Current for the control circuits may be obtained from the exciter busbars and, if it is thought necessary, a small storage battery may also be provided for such use, though there does not seem to be any real need for it because it is quite practical that all switch gear should be inoperative and open when the plant is shut down. All ammeters, voltmeters, wattmeters, etc., should be connected to their operating circuits through transformers and absolutely no main wiring should enter the desk. Wherever the main wiring, switches, etc., are located, they, of course, need not be ornamental but of rugged construction, and wiring connections should be of similar character and generously spaced for easy access and handling.

Switch gear, lightning arresters, etc., should be regularly inspected and kept in first-class condition but the station attendant should not be the one to make this inspection. The monotony of continual contact with his surroundings tends to render him oblivious to increase of wear and irregular operation of minor parts; inspection should be made by the superintendent. We know that very few switchboards in small plants are ever inspected beyond a casual glance at the mess at the back and a remark to the operator that he had "better remove that stick," or piece of waste or some other stray object. The first real evidence of anything out of order is usually a display of pyrotechnics and the operator is censured because he is there all the time and ought to know what is going on behind the board as well as in front. With the remote control he has no responsibility for the maintenance of the switchboard and the superintendent, who has, is given an opportunity to perform his duty and to have repairs made without danger of fireworks or shutting down the plant.

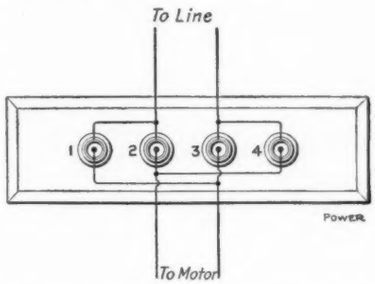
In substituting remote control for the old form of switchboard many changes suggest themselves in the methods of treating details. For instance, generator ammeters, wattmeters and field resistors are all local to their respective machines and in a small station it seems consistent and feasible to mount each set of instruments on a pedestal near the machine to which they are connected. The place for the resistor in the field circuit of a machine is adjacent to that machine, with either mechanical or electrical control at the desk. Voltmeters and feeder instruments should be at the desk, with the exception of recording instruments, the proper location of which is the switch room. With a diagram of the main circuits under a glass in the center of the desk the operator can always have a grasp of feeder conditions as changes or additions occur from time

to time. The advantage of having the operator familiar with the system outside the station can scarcely be exaggerated.

LETTERS

Substitute for a Double-throw Switch

After installing a 5-horsepower direct-current motor for driving a crab winch through a friction clutch, we found that the weight of the line would not run the winch backward after throwing out the clutch, so we decided to make the motor reversible. Having on hand neither a double-throw switch nor the material from which to construct one, we resorted to the arrangement indicated in the accompanying sketch.



SUBSTITUTE FOR A DOUBLE-THROW SWITCH

We mounted four incandescent-lamp receptacles on a board and connected them as shown. Then we short-circuited the terminals of two ordinary attachment plugs with pieces of No. 12 copper wire and screwed them into the different receptacles according to the direction of rotation required. With the plugs in Nos. 2 and 3 the motor runs one way and with them in Nos. 1 and 4 it reverses.

This arrangement works so satisfactorily that we have decided to leave it in use instead of putting in a switch.

W. S. YOUNG.

Cherokee, Iowa.

An Extension Brush Holder

We have a 150-kilowatt alternator of the compound-wound type and the brushes on the rectifying commutator had always given considerable trouble by sparking and cutting away. They are woven-wire brushes and had to be bent as shown in Fig. 1. As they wore down near the bend we could not get tension enough on them to hold them down on the commutator; then the sparking increased, and the more they sparked the worse they would cut. Besides, the flashing caused a flickering at the lamps due to the variation in voltage. In order to get around the difficulty, I made up a full set of extra brush holders, each consisting of a simple block with two slots through it and two set screws, as shown in Fig. 2. This holder was mounted on the end of a short brush which was set in the regular holder, and a working brush of regular length was clamped in the diagonal slot. The complete arrangement is shown in Fig. 3. This enables

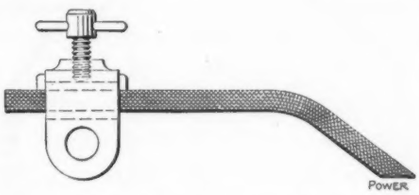


FIG. 1. THE REGULAR BRUSH

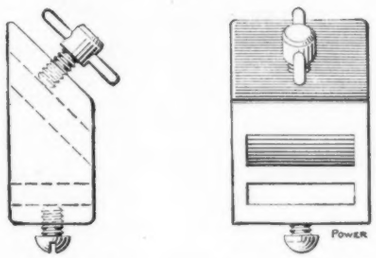


FIG. 2. AUXILIARY HOLDER

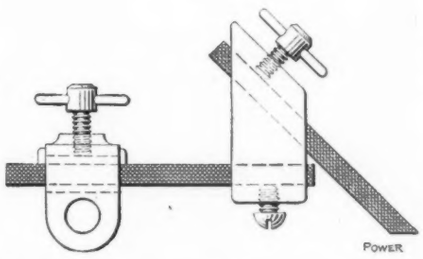


FIG. 3. APPLICATION OF AUXILIARY BRUSH HOLDER

us to keep the spring tension constant and to use up nearly all of the working brush.

E. M. GILBERT.

Nelsonville, O.

Starting a Large Motor Supplied by a Small Alternator

A factory was newly equipped with three-phase induction motor drive, the power to be furnished by the central station of the city. All the motors started their required load without difficulty except one of 50 horsepower. The customer tried in every way he knew to get this motor started but with no success. It was consequently declared defective and I was sent to locate the trouble. A thorough examination of the motor disclosed no defect except a ground in the rotor squirrel cage, and I knew that this would not necessarily interfere with the operation of the motor. The fuses, transformers and the inside wiring to the motor were found to be in perfect condition. The voltage of the circuit was tested and found to be normal.

Then we decided to give the motor another trial, but before doing this we connected lamps across the three phases in order to find out if there was an abnormal drop in voltage at the time of starting. With two or three men at the belt to aid the motor, the compensator switch was thrown in. The motor hummed, made a feeble effort to start, and the test lights showed extremely low voltage on the line. As the torque of an induction motor varies as the square of the applied voltage, one-half of the normal voltage would give only one-fourth of the normal torque, so it was now no wonder to me that the motor refused to pick up its load.

We inspected the line leading from the power house and found it was large enough to carry the current without any appreciable drop in voltage, and I felt sure that they were not running the voltage down at the central station while the motor was being started. Upon investigation at the power house we found that the current was supplied by a 100-kilowatt alternator, and observing the voltmeter on the switchboard while the motor was given another trial start showed that the heavy lagging current taken by the relatively large motor weakened the alternator field and reduced the e.m.f. to about half the normal voltage.

As a makeshift we tried running the voltage up while the motor was being started; it was run up to 15 per cent. above normal and when the motor hit the line we immediately cut all the resistance out of both the alternator and exciter field rheostats. The busbar voltage was thereby held about normal and the motor speeded up with its load with the greatest ease. This method had to be used in starting this motor until a larger generator was installed.

G. J. REYNOLDS.

Anniston, Ala.

The portion of the feed pipe in the boiler should be suspended by stout wires from the braces and not be allowed to rest upon or across the tubes. Tubes are sometimes cut through by the continual movement of the feed pipe upon them, due to the pulsations of the feed pump. The pipe should be put together in sections so that it may be removed and cleaned.—*Ex.*

When the belt has become oil soaked and will not stay on the machine, a good method of cleaning it is as follows: Coil the belt loosely in a tub of sufficient size, and cover with whiting. Be sure that the whiting gets in between the coils of the belt, and it will be only a short time before the whiting will absorb the oil from the leather. It will then only need to be wiped clean to be ready for further service.

Gas Power Department

Everything worth while in the gas engine and producer industry will be treated here in a way that can be of use to practical men

Running a Gasolene Engine with Kerosene

By M. W. Pullen

It is well known that for a hydrocarbon engine to run properly it is necessary that the fuel be finely atomized (preferably vaporized) and thoroughly mixed with the intake air. With gasolene engines and some forms of kerosene and crude-oil engines the problem of obtaining the proper mixture has been solved in a number of ways which are quite satisfactory. With a kerosene engine, vaporization of the fuel is much more difficult than in the case of the gasolene engine, because kerosene is not as volatile as gasolene. If, then, an attempt be made to use kerosene as fuel for an engine normally adapted for gasolene, trouble is likely to arise from failure to vaporize the kerosene.

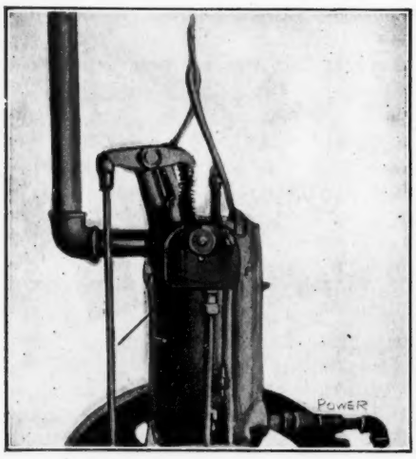


Fig. 1. Gasolene Feeder

This trouble was very noticeable in the case of a small engine which was supposed to be properly equipped to burn kerosene. The engine was fitted with an atomizing mixer very much like that used by the manufacturer for gasolene. Fig. 1 shows the atomizer used for gasolene on the type of engine under discussion; the arrow points to the air-intake opening. Fig. 2 shows a vertical section (not to exact scale) of the device taken at right angles to the needle valve and Fig. 3 a vertical section partly in the plane of the needle-valve axis. It is clear that as the intake air is drawn into the cylinder it sucks a certain amount of fuel through the small nozzle and the two mingle in the short passageway to the cylinder.

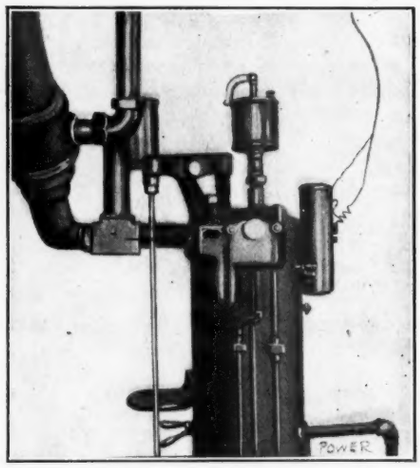


Fig. 4. Kerosene Feeder

Fig. 4 shows the atomizer that is used for kerosene. The similarity in appearance of the two is quite marked, the kerosene device differing only in having the retort at the left. The intake opening is located somewhat differently, however, as indicated by the arrow. The retort, which is the only essential difference between the two types of atomizer, is arranged to be heated with a blow torch in case it is desired to start the engine on kerosene. In this case the large sight-feed oil cup shown just above the needle valve is screwed into an opening directly over the retort; this opening is indicated in the sectional view of Fig. 5. The function of the sight-feed cup is explained later. The portion of the kerosene atomizer which is not shown in Fig. 5 is exactly like the corresponding part of the atomizer represented in Figs. 2 and 3. Vent holes are provided for the escape of the hot gases of the blow torch from the jacket space *J* but they do not show in Fig. 5; one may be seen near the top of the retort in Fig. 4.

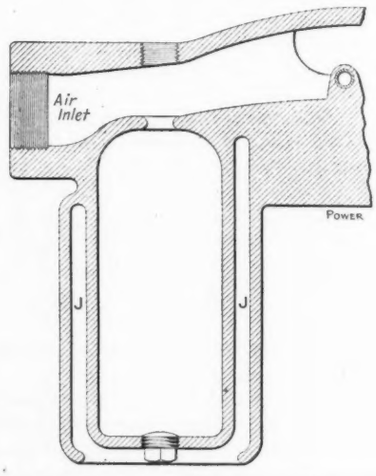


Fig. 5. Section of Kerosene Vaporizer

To start the engine with kerosene, the sight-feed cup is filled with the fuel and the retort is heated at the bottom. When it is hot enough, the cup is opened and the kerosene drops down into the retort, where it is vaporized. The kerosene vapor rises into the air passage and mixes with the air drawn into the cylinder by the suction stroke of the piston and the ordinary cycle of operation

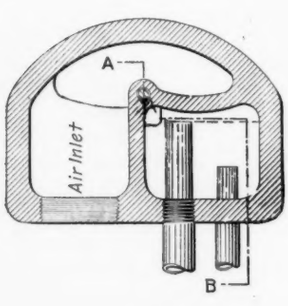


Fig. 2

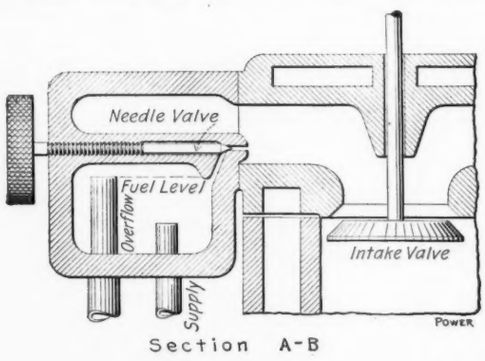


Fig. 3

Sections of Gasolene Feeder

started. After the start the needle valve is opened, the oil cup shut off and the kerosene is thereafter fed to the engine in exactly the same way that gasolene is fed in the gasolene atomizer. The retort, of course, goes out of use until another start is made.

If there is gasolene at hand the sight-feed cup may be mounted in the position shown in Fig. 4 and the engine started by allowing gasolene to feed from the cup into the air passage of the atomizer, whence it is swept up by the air and forms an inefficient mixture but one good enough for starting. After the engine has run for a few minutes, the gasolene is shut off and the needle valve opened; regular operation on kerosene follows. This latter method of starting is much handier than the former, and if it be used the retort is unnecessary, a simple gasolene atomizer being sufficient as far as running is concerned. No provision is made for vaporizing the kerosene; it is simply atomized by the nozzle.

The engine with the kerosene (retort) feeder gave trouble almost from the time

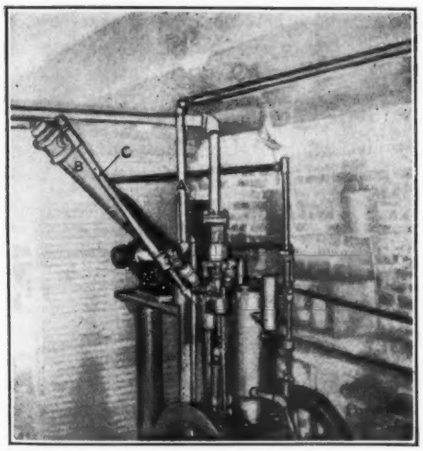


FIG. 6. INTAKE-AIR HEATER

it was put into operation. It used a great deal more fuel than it should, even when the needle valve was regulated to give the least amount of fuel that would enable the engine to run smoothly.

The second trouble was in lubrication. The engine, as will be noted, is vertical with a closed crank case, being oiled by the splash system. The hight of the oil in the crank case was noted daily and each time it was necessary to *draw off* oil instead of adding more; the amount drawn off was greater than the amount added by the oil cup which was supposed to keep up the supply. Then, again, the oil worked out through the main bearings and getting on the flywheels it spattered two streaks on the floor and ceiling of the room.

The cause of the lubrication trouble was not discovered for some time. However, it became necessary to draw the oil all off about a month after the engine was set up, and the oil was saved with the idea of using it again. It was noticed that it had a peculiar appearance, was very thin, and did not feel very smooth between the fingers. A close examination showed that it was a mixture of cylinder oil and *kerosene,* mostly kerosene. . .

From this discovery it became evident that the kerosene was not being fully burned and that some of the unburned part of it worked down into the crank case; perhaps a good share of it went out through the exhaust port.

In Fig. 6 is shown the remedy adopted. A jacket of 3-inch pipe fittings was put on the exhaust riser, which is of 1½-inch standard iron pipe, and the intake air was led through it. The air comes from out-of-doors through the small vertical pipe *A,* entering the bottom of the heater *B.* The air then rises along the hot exhaust pipe and out at the top by way of the pipe *C,* which leads down to the atomizer. The heated air serves to help vaporize the kerosene.

It is now necessary to add oil to the supply in the crank case and, what is more important, the kerosene tank does not have to be replenished nearly as often as before with the same engine load. No exact data as to the saving can be given, but it is estimated that with the heated air only about three-quarters as much fuel is used as when the engine was supplied with cold air.

Steam Engineers for Gas Power Plants

BY CHARLES O. HAMILTON

"Whom have you picked out to take charge of your power plant?" is the way I generally bring up the matter of attendance in going into details with a gas-engine buyer. I am not likely to say "engineer"; it's mighty apt to start something.

After explaining the need for attendance and the buyer understands the matter, it is only natural for him to say, "How will my present steam engineer answer?" This is a most natural suggestion. Why not the present engineer?

Unfortunately, the engineer himself in many cases has made his selection as the gas engineer a bad move for his employer. The reasons may be many, but foremost is the prejudice that he has cultivated for the gas engine. He would be out of harmony with gas power; until he had weaned himself from his first love and formed an attachment for the new power he could not hope to succeed. The chances are that he has opposed the purchase of the gas plant and his personal feeling prejudices the builder against trusting him to operate the engine.

Even though he had taken a broad-minded position, advising fairly on such points as were put up to him during negotiations, there might be still many things which would make his selection as operator of the plant seem inadvisable. Chief among these objections is usually the fact that unless he has been more progressive than the average engineer he has not equipped himself with any knowledge of gas-engine operation, having assumed that if he should ever be called upon to operate such a plant his knowledge of steam engines would enable him to step in and make good immediately. He is apt to scorn A, B, C instructions and the need of his making-over that is requisite to change from steam- to gas-engine operation.

A good steam engineer has a great many points to recommend him. He is not afraid of the noise and the moving parts of an engine, whereas a man of other training would be timid until he became used to the surroundings. His training has made him thoughtful and watchful of details; he does not forget to do the little things. He has self-reliance and presence of mind in an emergency—a most valuable asset. He knows the plant, knows the ins and outs of everything, probably having installed or renewed a good part of it if long in his position. To have been a successful steam engineer he must have been of good habits. He must have been something of a mechanic in order to keep his plant in shape.

Every one of these things counts in his favor as a gas-engine operator, but if he is prejudiced against gas power or has been so indifferent that he has made no study of its peculiarities, the favorable points will not suffice to make him eligible.

Steam engines and gas engines are both machines for converting heat into mechanical energy. But aside from this function there is mighty little similarity. They are decidedly unlike in operation. Conditions in the steam cylinder are materially different from those in the gas cylinder because steam differs, of course, from flame. Steam exerts a fairly even continuous pressure on the working parts; gas pressure starts with an explosion and diminishes rapidly; it is also intermittent. Lubrication, packing, valve conditions, are entirely different. Even the bearings require different handling and adjustment. The control of the fuel and ignition does not correspond at all to handling steam.

The steam engineer served a long time to learn steam-engine operation. The gas engineer, to be equally proficient, must serve and study too.

The ordinary steam man usually begins his gas-engine apprenticeship by far underestimating his need for special knowledge and training, and is inclined to feel that changing to gas power is a step downward. The fact that he has been "it" in the old plant often leads to a resentful, obstinate, overwise bearing in receiving instruction regarding op-

eration of the gas engine. Starting up looks so easy in the hands of the erecting engineer that he assumes there is nothing to it. He despises suggestions of a routine, preparing to start and stop.

When anything goes wrong, he will hark back to his old plant and when he cannot figure it out he blames the gas engine. He will make about as ridiculous mistakes in his new work as an inexperienced man would make with steam—mistakes he would laugh at in a steam engineer, yet he does not see the joke when we laugh at his bungling with the gas engine.

When we find an old steam engineer who is wise enough to know that he does not know about gas power and really wishes to learn, there we find an ideal candidate for a gas engineer.

The gas engineer in Europe must make his engine perform well up to its possibilities or lose his standing as a mechanic. It is so in this country with steam engineers, and eventually it will be so with gas-engine operators.

There is another feature that steam men do not always like. The medium-sized gas plant, say, of 20 to 200 horsepower, using natural gas, city gas or gasolene, will not require over two hours' time out of the eight, nine, ten or eleven hours which the operator puts in. (In this time estimate I am considering a plant where the engine is belted to a line shaft.) If a suction-gas producer is used, another hour will be sufficient to care for that. Consequently, the gas engineer must occupy himself for the greater part of the day with other work.

Here, again, we are apt to find the steam man with his hair rubbed the wrong way. Where there is any auxiliary machinery, such as dynamos, pumps, compressors or a heating system, to take up his time he is satisfied, but when the spare time must be put in at some regular work, like running a lathe or other production machine, he is apt to buck, and rather naturally, because this usually forces him to learn two trades, gas engineering and machine-tool operation. Under such circumstances, the steam engineer is at a disadvantage compared with a man taken from some machine in the shop, who willingly masters the gas engine as a side line to running his regular machine. But there are hundreds of industrial establishments in which working at a distinct trade in addition to running the power plant is not necessary. Only the ordinary kind of mechanical work, such as the care of belts, shafting, hangers, etc., is required. Here the steam man ought to shine if he would take the proper interest in gas power.

There is a growing demand for competent men in this line of work. We know it from the continual efforts made by engine buyers to hire our field men and experts away from us to take charge of their power plants.

What I have written here is not intended as an argument for or against the steam engineer in the gas plant. It is intended merely to tell some facts which I know to exist, some facts that are not always quite apparent to the people who buy engines and those who run them.

I do not know that the average steam engineer wants to take hold of a gas plant such as might be bought to replace his steam plant, but if he knew the possibilities for more money—and that is what most of us work for—I should think he would be anxious to do so. My experience indicates that the man who can successfully operate a gas-power plant and make himself of real service in his spare time will easily earn at least 25 per cent. more money, with shorter hours and cleaner work, than he could get in the average steam plant of the same horsepower. Perhaps he would not get it at the start, but why should he expect it? He is learning a new trade then.

Essential Factors in Making Producer Gas

Bulletin No. 7, just issued by the Bureau of Mines, describes the results of some interesting investigations, made by J. K. Clement, L. H. Adams and C. N. Haskins, of the processes that take place in a gas producer. One of the chief objects of the work was to determine the effect of temperature upon the proportion of carbon monoxide obtained. In experiments made by Mr. Clement at the Norfolk plant of the United States Geological Survey, it had been found that the temperature in the generator varied greatly in different parts of the fuel bed. In order to ascertain the conditions of temperature most favorable to efficient operation it became necessary to determine the temperature required for the formation of carbon monoxide and hydrogen.

The investigations described in the bulletin demonstrated that a very high temperature is necessary for the maximum production of carbon monoxide from carbon dioxide and carbon. Other conditions, however, are against operating the decomposition zone of the fuel bed at extremely high temperatures—much above 1300 degrees Centigrade (about 2400 Fahrenheit). A very hot fuel bed means that the gases will leave the generator at a high temperature and thereby lower the efficiency of the producer unless the heat of the gases could be used for generating steam or preheating the air blast. High temperatures also favor clinkering. In the application of the results of these experiments to commercial producers and furnaces it will be necessary, of course, to consider the other questions which are involved.

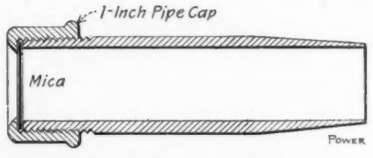
The investigations also demonstrated that the higher the velocity of the gas through the fuel bed and the thinner the bed, the smaller will be the percentage of carbon monoxide formed; also, the greater the supply of air to a given depth of bed, the smaller will be the percentage of this gas formed.

The use of large amounts of steam is inconsistent with the realization of high temperature, and is, therefore, to be avoided. Moreover, on account of the large percentage of carbon dioxide that is formed when a relatively large quantity of steam is used, it is doubtful if a real gain in efficiency is obtained.

CORRESPONDENCE

An Airtight Peephole

For a long time I followed the common practice in the operation of gas producers of using the opened pokeholes as peepholes for inspecting the condition of the fuel bed, wishing all the time that some other way could be devised. Finally I hit upon the simple arrangement illustrated by the accompanying sketch and now I never need to open a pokehole to the air except for actually poking the bed. The arrangement shown consists of a piece of 1-inch pipe 6 inches long, capped at one end and slightly tapered at the other, with two sheets of mica clamped



INSPECTION PLUG FOR POKEHOLE

between the capped end of the pipe and the inner face of the cap; a hole drilled through the center of the cap permits me to look through the mica at the fuel bed and I can look as long as I like without admitting air. I insert the tapered end of the peep plug into the pokehole and remove it, of course, when I bar the fuel bed.

N. A. LEE.

Hawley, Minn.

A 63-ton shafting has recently been placed in the engine room of the Sharp Manufacturing Company's mills in New Bedford, Mass. To move the huge piece of metal from its bed on a flat car to its position in the engine room required the work of ten men and two large steam road rollers for two days. A cylinder weighing 29 tons had previously been placed in position.

Just because you do not get a raise in pay every few months is no sign that you are not appreciated. Things might have been worse. You might have got fired.

Readers with Something to Say

Practical information from the man on the job. A letter good enough to print here will be paid for. Ideas, not mere words wanted

Inspirator Troubles

Some years ago I had trouble with an inspirator. The conditions under which it worked were severe and different from what the device was designed to work under. It received its water supply under a head of about 45 pounds; the water pipe was the common supply for two power pumps, and the steam supply came from a main that supplied two air pumps and a duplex steam pump.

As long as the steam pressure would be kept up to 140 or 150 pounds per square inch, the inspirator would work properly, but as soon as the pressure dropped, as it would through the night, trouble would be experienced. In starting the inspirator, it would only run a few minutes and then break. The trouble was with the water supply. The inspirator was made to lift water, and when doing so works satisfactorily with widely varying steam pressure.

With the inspirator connected to a water supply under pressure, the valve on the suction pipe should be throttled until just the right amount of water is admitted; otherwise the inspirator may break. In starting up under such a condition the steam should be turned on first; then open up the water-supply valve a little and draw over the starting lever, for, when lifting the water, it can easily be determined if there is too much or too little. It is a matter of rather nice adjustment, depending on the steam and water pressure, but after a few trials one can judge the right amount of opening the suction valve needs.

H. X. GSKHE.

North Cambridge, Mass.

Flywheel Worked Loose

One morning, after I had started a 12x 12-inch automatic high-speed engine, my attention was arrested by a loud grating noise. When the governor "came out" the noise stopped, but it was succeeded by a rapid pounding. I shut down and as the governor "went in" the pounding ceased and the grating began.

I found that the governor was rubbing against the eccentric oil guard, which was caused by a loose and shifting flywheel. I could think of no easy way to shift the wheel back to place, so I tightened the set screws in the hub and started up again. This time there was no pounding and the engine ran very well all day. The wheel was about ¼ inch out of position on the shaft and this drew the eccentric out of line with the valve rod. Putting the wheel back into position was a difficult matter, for it was a side-crank engine and the flywheel and armature were so close to the main and outboard bearings that there was not enough room for the usual make of jacks.

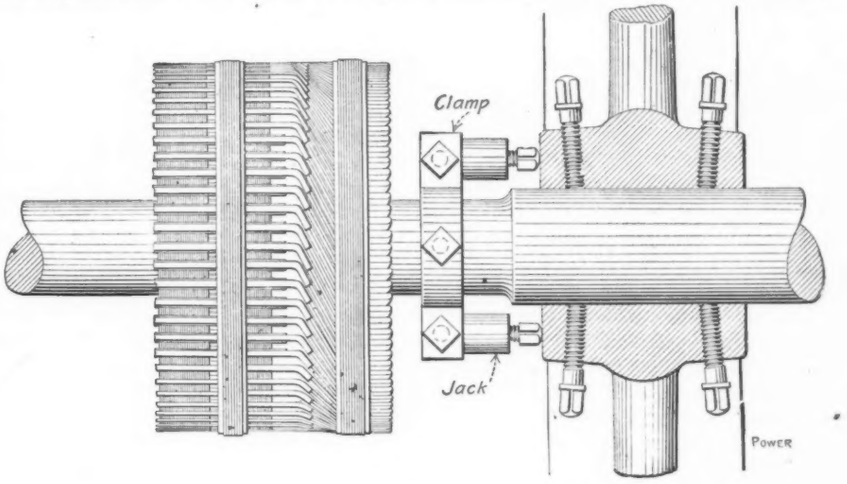
During the day I made two jacks by sawing a 2½-inch cast-iron bar in 3-inch lengths. I drilled and tapped them for a ⅝-inch set screw, shown in the accompanying illustration. I also made a clamp to fasten to the shaft. The clamp contained two set screws which were to be used for gripping the shaft after the clamp bolts had been tightened as much as possible. With the clamp in position on the shaft, the base of each jack was placed against the clamp ends and the heads of the set screws were placed against the hub at the flywheel. I then loosened the set screws in the wheel hub and with a small monkey wrench began to screw out on the jacks. Presently the wheel began to move and in a few minutes it was back in place.

I then took some putty and plastered it all around the shaft close to the hub and after removing one set screw out of the hub I poured in a solution of salammoniac and water and allowed it to stand until the next morning. The clamp and jacks were then removed, the engine was started up and no trouble has been experienced since.

The object of using sal ammoniac was to rust the wheel and shaft together.

J. ENGLAND.

New Haven, Conn.



JACKS USED TO FORCE FLYWHEEL INTO PLACE

Some Power Cost Figures

Some interesting figures on the cost of producing power in a plant which sells its exhaust steam for heating during the winter months have recently been reported. These figures refer to the plant of the Wells Power Company, of Milwaukee, Wis., the power plant of which is an outgrowth of a small isolated plant installed to furnish power and heating for several neighboring buildings in the center of the business section of the city, and at the present time furnishes power and exhaust steam for heating to customers within an area of 2½ square miles.

When the original isolated plant was outgrown a new plant was built to be operated in parallel with the former, each plant being situated in the basement of a mercantile block. The old plant had a capacity of 550 kilowatts and 960 boiler horsepower. The new plant at present contains 1000 kilowatts in generators and 1524 horsepower of boilers, and there is provision for eventually more than doubling this capacity.

During the year ending July 1, 1910, the total generated output was 1,561,410 kilowatt-hours, of which 1,275,455 kilo-

watt-hours were sold to outside consumers, the remainder being used through the company's buildings. Based on the kilowatt-hours sold, the total earnings were $0.097 per kilowatt-hour, divided into $0.056, earned by the sale of electrical power, and $0.026 credited to heating; the remaining amount represents miscellaneous income. Against this earning the total expense charged, which includes depreciation and taxes, amounted to $0.075, giving a net profit of $0.022 per kilowatt-hour.

In order to furnish a real basis for comparison with isolated plants and central stations, it is more logical to take the figures for kilowatt-hours generated rather than the amount sold. On this basis the figure for total earning per kilowatt-hour are $0.079 against a total expense of $0.062.

In considering these results allowance must be made for the fact that, owing to the location of the plant and the impossibility of obtaining the large quantities of water necessary for condensing without undue expense, it is necessary to operate this plant noncondensing in the summer time as well as during the winter when exhaust steam is used for heating. If it were possible to run condensing during the warm weather, the total expense figures would undoubtedly be materially lessened.

H. M. Wilcox.

Boston, Mass.

Smoke Preventers

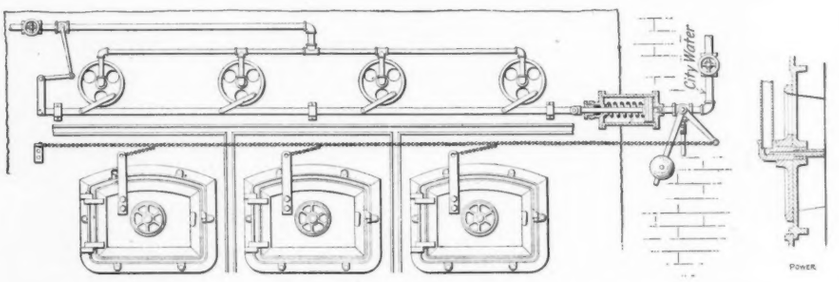
I carried out several experiments some years ago with a so called smoke preventer, the principle of which was to admit steam and air over the fire while the volatile gases were being distilled. The fronts of our boilers were badly cracked. The doors were each 24 inches wide by 20 inches high, and considerable air was admitted when firing and cleaning the fires, causing a serious reduction in steam pressure as the load carried was very heavy.

Patterns were made and a new front with three doors each 18x14 inches was cast and put on one of the boilers. After this was done it was noticed that the stack of the boiler with the remodeled front smoked for a longer period after each firing than the boilers with the old-style front, which was believed to be due to the new front being tight and shutting out the air over the fire.

It was then decided to put on a steam-jet smoke consumer, which was done by piping steam to the inside front wall. A ¾-inch supply pipe fed the ½-inch branch pipes, which were fitted with nozzles made with a very thin, wide opening, in order to spread the steam over the entire fire. This device was tried on one of the old-style fronts, steam being turned on as soon as the doors were closed after each firing. On trial it was found that with the jet on and doors closed the black smoke was reduced to nearly one-half of what it was without the jet, and still better stack results were obtained with the fire door slightly open; the coal consumption was also increased and the feed valve was opened about one turn more to make up for the increased evaporation, due to a hotter fire with better draft rather than more complete combustion.

As this device depended upon the fireman for operation, it would either be left on all the time or not turned on at all.

These results lead to a second experiment on a larger scale with a more complete and automatic device, which is shown in the illustration and was applied to the new front. It consisted of four draft plates 7 inches in diameter, fastened to the boiler front, through which holes were drilled to correspond to the openings in the plates. A hole equal to the area of the opening in each plate was also made through the front brickwork and pitched slightly downward, so that the air and steam would tend to strike the bridge-wall about 2 feet over the fire. Superheated steam was admitted through the ⅛-inch nozzle placed through the center of each plate, which also acted as a bearing on which the plate could revolve.



Control of Steam Jet As Attached to the Front of the Boiler Setting

The draft plates and the butterfly valve in the steam line were operated by a cylinder 4 inches in diameter by 8 inches in length, and closed by a heavy spring on one side of the piston in the cylinder. Water under city pressure was admitted to the cylinder through a three-way valve which was opened as the chain was pulled when opening the fire door; when the door was closed, the three-way valve was closed by a weight and the water gradually drained out of the cylinder through a ¼-inch pet cock.

Steam was superheated by means of 12 feet of ¾-inch pipe placed crosswise of the boiler over the tubes. Both steam and air were gradually shut off by the action of the spring in the cylinder, and could be regulated to close in from 1 to 10 minutes, the duration of the steam blast being determined by trial, the idea being to diminish the amount of steam and air as the volume of volatile gas was decreased. A globe valve was placed in the steam and water lines in order to make changes and cut out at cleaning times.

This boiler was tested in comparison with another boiler fired alone and on another stack. Smoke was greatly decreased over that coming from the other stack without the jet, and better results were gained by having the fire doors open about 2 inches for three minutes after firing and also by firing alternately one-half of the grate at a time, which led to the conclusion that the plates were too small.

I had no CO_2 recorder, so I do not know whether the percentage of CO_2 was increased or not by the use of the "consumer," but, in every case when the device was turned on, the water tender gave the feed valve an extra turn open, and also several more barrow loads of coal were used per day, which led me to believe that the capacity of the boiler was increased, and the clinker was more brittle and easier to get out.

In order to observe the decrease in smoke, the device was left closed until the dense, black smoke was rolling out of the top of the stack, and then put on, the result being that the smoke instantly changed to light gray, and, if the steam jet was shut off again, black smoke would again issue from the stack.

These boilers were worked at full capacity and on a very poor draft. The coal was bituminous run-of-mine, containing about 13,500 B.t.u. and 15 per cent. ash; therefore, it was necessary to fire very light and often, or about every 5 minutes, using not over four small scoops at each alternate firing. In this plant is also another battery of water-tube boilers with the same kind and size of grate, but set in a dutch-oven furnace, the arch being 8 feet long and about 4 feet high in the center. Firing the same amount of coal in the same manner in this type of furnace gave a much cleaner stack than was possible with either the steam jet alone or combination of air and steam with the ordinary furnace.

I believe that the "smoke consumer" shown herewith, properly designed and set in a dutch-oven furnace, will not only produce a clean stack, but will increase the capacity of the boiler and give a high per cent. of CO_2 and better combustion.

The results obtained with the different types of furnaces and methods of firing are given herewith, and in each case the boiler was run at full capacity and fired in the same manner and by the same fireman.

The figures correspond to the numbers used in the Ringelmann smoke chart:

Boiler and furnace..	Average Per Cent. of Time for Each Condition.					
	No. 5	No. 4	No. 3	No. 2	No. 1	clear
Stirling boiler, dutch-oven furnace, no jet or air over fire, No. 5 boiler....	5	15	25	10	25	20
"Smoke consumer," Fig. 2, in operation on No. 4 boiler.....	10	15	20	20	25	10
Boiler with smoke consumer cut out.	55	30	10	5	0	0
Boiler No. 3 with steam jet, Fig. 1, cut in, old front..	20	20	20	20	15	5
Boiler No. 3 with steam jet cut out, old front.....	40	25	25	10	0	0

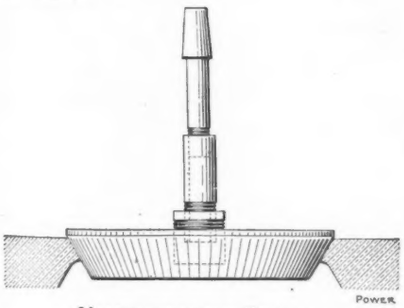
No. 4 boiler was equipped with the new three-door front when the test was made. It will be seen from the above table that No. 4 boiler, with the new front with air and steam shut off over the top of the fire, also with the original style of front as shown in column five, never showed a clean stack.

J. C. HAWKINS.

Hyattsville, Md.

Regrinding a Safety Valve

It was necessary to grind a pop-safety valve so I began to think up a convenient method of turning the valve, which was not made fast to the stem and was threaded for a 1¼-inch pipe in the center.



VALVE-GRINDING DEVICE

I, therefore, made the tool shown in the illustration. The square shank end was cut from an old bit and a short piece of ¼-inch pipe shrunk on the round end. A thread was then cut on the end of the pipe and a ¼x1¼-inch bushing was screwed on it. The whole was then screwed into the valve.

A bit brace was used to turn the valve disk on its seat. The valve was then readily ground in.

This tool will often come in handy as any size of bushing may be used.

HOWARD R. TAYLOR.

Norwich, Conn.

Babbitting Bearings

Most all of the so called anti-friction metals are composed of an alloy of two or more metals, such as copper, tin, antimony, bismuth and lead. Babbitt metal, however, has come to mean a metal containing any part of these metals, the base being chiefly lead.

Twenty-four parts of antimony and 76 parts of lead appear to be the proper mixture of the two metals, because 24 parts of antimony seems to be the maximum amount that will unite with lead to form a complete alloy. Considerable care is necessary in preparing these alloys because the melting temperatures of the component metals are so different.

Most engineers are aware that old babbitt metal after having been used and remelted a number of times loses its fluidity and becomes more and more pasty the more it is used until it will not make a sharp, smooth casting. This is due to the rapid vaporization of the more volatile metals and the oxidation of other metals of which the babbitt may be composed. When babbitt metal has reached this condition it is practically worthless, but it can be restored to its normal fluidity, to a certain extent, by the addition of a small amount of lead. Pieces of old type metal would be more beneficial than lead as, owing to its composition, it not only restores the normal fluidity, but will improve the quality of the babbitt in general.

There are numerous ways of babbitting a box or journal. One very good way is to level and line up the shaft by putting small cubes of wood under it in such a position that they may be taken out after the babbitt has been poured, thus leaving small pockets for the oil under the shaft. These pockets will get full of oil and in case the journal begins to heat, due to a stoppage of the oil feed, etc., the oil from these pockets will work up to the bearing and thereby protect it from any very serious damage.

A good way for babbitting bearing for small shafts is to wrap common writing paper around the shaft and fasten it with coarse twine. The babbitt will run more smoothly by coming in contact with the paper covering than when coming against the cold surface of the shaft, although the shaft may have the chill removed by means of a blow torch before pouring the babbitt. The paper and cord method is preferable as the thickness of the paper will compensate for the slight shrinkage of the metal so that it will not be necessary to do as much scraping as would otherwise be the case.

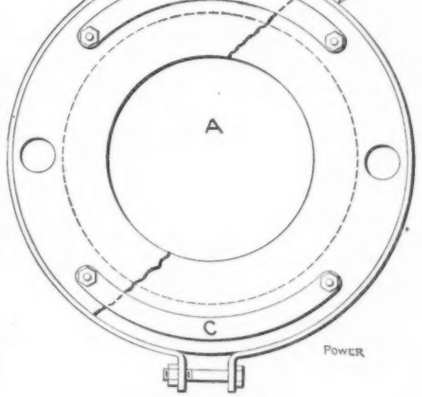
If the twine is properly wound around the shaft, care being taken not to allow the twine to extend to the end of the box, but having it terminate in a complete circle about ½ inch from the end of the bearing, the oil will not run out at either end of the bearing. The ends of the bearing must be filled with something to prevent the metal from running out while pouring. This may be done by placing a pasteboard washer on the shaft up close to the end of the bearing and packing all small intersections with putty or soft clay paste. Then the bearing may be poured and a good bearing obtained.

CHARLES H. TAYLOR.

Bridgeport, Conn.

Repairing a Broken Pump Gland

A 12 and 9 by 14-inch pump of the pot-valve center-packed type had a cracked gland, as shown at *A* in the illustration. As a new gland could not be



REPAIRED PUMP GLAND

procured within two weeks, and as the pump had to be ready for the line for the peak load, I made the repairs as follows:

I got some ¼x1-inch stock and made a strap to go around the outside of the flange, as shown at *B*. By drawing up on the bolts the gland was held together. Then I made two clamps, as shown at *C*, out of some ⅜x¼-inch stock, and drilled a $\frac{13}{16}$-inch hole in each end so that the clamps would fit over the studs. These clamps were fitted to the top and bottom studs, which enabled setting up the packing and prevented leakage.

When packing pumps of this type, care should be taken that all the old packing is taken out and that the plunger is central in the stuffing box. If the plunger sags and there is more clearance at the top, a jack screw put under the plunger or rod, whichever it may be, will equalize the clearance around the plunger in the stuffing box.

I find that by soaking the packing in oil over night and cutting it ⅛ inch short it gives better results and wears longer.

J. NUGENT.

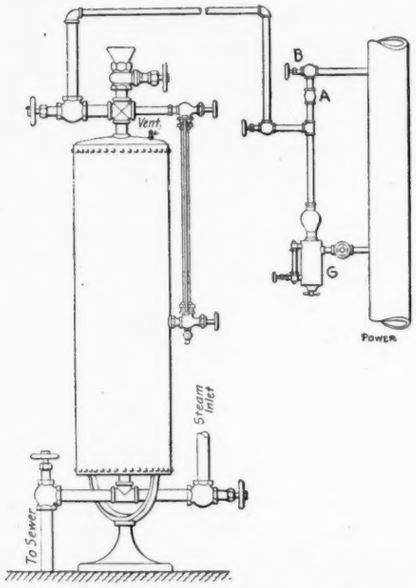
Cambridge, Mass.

Questions Before the House

Comment, criticism, suggestions and debate upon various articles, letters and editorials which have appeared in previous issues

A System of Lubrication

About three years ago I rigged up an oiling system in the plant where I am employed similar to the one described by Charles P. Weaver in the March 28 number of POWER. I connected the system up as described by Mr. Weaver with the addition of a check valve in the oil pipe close to the reservoir, which prevents any oil from returning to the reservoir when pressure is off. I provided a funnel similar to that shown in Mr. Weaver's sketch, through which to fill the reservoir. My reservoir contains enough oil to last six



MR. WEAVER'S OIL RESERVOIR

weeks, at the end of which time I find that I have quite a job refilling the reservoir.

As every engineer knows, cold cylinder oil has cold molasses beaten to a frazzle when it comes to slowness, and in handling any quantity of it he is quite likely to get his hands and clothing soiled, besides consuming a lot of time. To avoid this annoyance I ran a 1¼-inch pipe from the top of the reservoir to the oil barrel, entering the barrel at the bung and extending the pipe to about one inch above the bottom of the barrel. I put a union in this pipe 3 inches above the barrel and a globe valve just over the union, so that an empty barrel can be easily removed and a full one substituted. The oil barrel is set on skids about one foot higher than the bottom of the oil reservoir.

When the reservoir needs refilling I simply close the steam or water inlet to the reservoir, open the outlet to the sewer and open the two valves in the pipe between the reservoir and the oil barrel. The water runs out at the bottom of the reservoir and pulls the oil out from the barrel, filling the reservoir with oil as fast as the water runs out. We do not have to handle the oil at any time. The pipe from the barrel to the reservoir should be filled with water or oil to start the outfit, which is simply a siphon. If no air is allowed to get into this pipe it always works; but to fill the tank quickly when the plant is running, I have a ½-inch pipe running from the bottom of the reservoir to my condenser, with a valve close to the condenser. This pumps the water from the reservoir and fills it with oil in a very short time.

W. T. PIPER.

No. Andover, Mass.

The Point of View

The front-page editorial of the April 18 issue of POWER gives a good suggestion to engineers as to how they might make their work more interesting. A man can do much better work when he takes a genuine pleasure in what he is doing than when only working to put in time so as to be able to draw a salary. However, the engineer is not always to blame, for while there are men who would not do the right thing no matter how fairly they are treated, there are some men who would be of use if they were rightly handled.

Take, for example, the young man commencing to learn the business and suppose he gets into some plant where the chief engineer is a man who thinks that everybody is trying to get his job and therefore is afraid to teach the young man anything of real value. Then there comes the time when the engineer is in need of an assistant. The young man does not get the job, for he has not been trained properly for it. So he is told that he does not know anything and never will know anything. How does he feel? How would any man, with a spark of pride, feel? Would he not be pretty much discouraged? A man treated like this may never rise above an ordinary helper. He has been spoiled at the outset. If any of the firm should inquire about him, the chief will say he is no good, so they fire the boy and hire somebody else. If it had been the case of a machine which had cost a hundred dollars or so, there would have been an investigation to fix the blame.

In my opinion, the average man who starts out to learn a trade has, if not the right view, the right spirit, and it is up to the man he is working for to develop him so that he may be valuable to others and himself. The beginner often believes that every man is an expert in his line and that each one is doing his best; but how rudely he is "brought to earth" when he finds that 90 per cent. of his fellow workers are just mediocre workmen.

Some years ago, I read an editorial in an engineering paper on the statement of an engineer who refuted the fact that an employer did not buy proper supplies for his plant. At the time it had not been my opportunity to see much of the methods employed in steam plants, so I thought this editorial unusual; now I know better. Anybody with experience knows that firms that buy the best supplies on the market are in the minority. I know of a plant belonging to one of the largest corporations in New England which buys a cheap grade of packing intended for 75 pounds pressure and uses it on superheated steam at 135 pounds. The chief can get nothing better. This tends to spoil his "point of view" somewhat.

As it is true that the engineer often considers his work a dull, monotonous drudgery, it is also very true that he is not wholly to blame. The layman is looking from a wrong "point of view" which cannot take in all the things that the engineer sees. If a fireman should call himself an "industrial chemist" in the hearing of some employers and some chief engineers, no matter how good a workman he may be, they will say that he is crazy and will fire him out of the plant. If he happens to be a young man, it will alter his "point of view" somewhat.

I claim that many engineers would take great pleasure in their work if they were allowed to do so by their employers. It will be found that those who are the

most successful are those who are appreciated by their employers. This gives them added confidence and an opportunity to expand and develop in knowledge.

G. H. KIMBALL.

East Dedham, Mass.

Constant Receiver Pressure

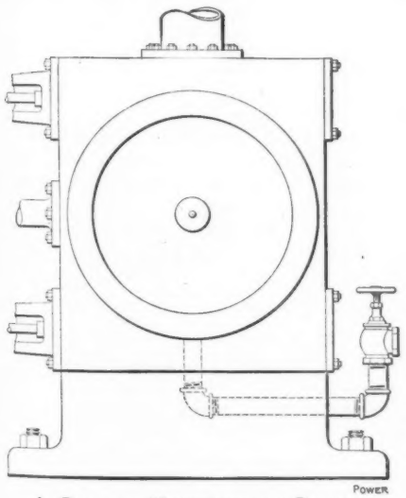
W. R. Beard, in the March 28 issue, gives it as his opinion that the cylinders of a compound engine should each do the same amount of work, and that it is better to maintain a constant receiver pressure under all loads.

In my opinion the receiver pressure should be such that the governor will revolve in its highest plane regardless of whether one cylinder does more work than the other or not. The engineer's problem is to keep the wheels turning with as little coal as possible, and it goes without saying that with the shortest cutoff in the high-pressure cylinder the steam consumption will be least.

Exeter, N. H. L. JOHNSON.

Unnecessary Clearance Loss

Under the above heading in POWER of April 25, S. Kirlin writes of the extravagant steam consumption of a four-valve engine equipped with relief valves and connected as shown in the accompanying illustration. I fail to see how this would affect the economy. The 3 feet



A CASE OF UNNECESSARY PIPING

of 1½-inch pipe within a few minutes would fill with water; hence, the connection would add nothing to the clearance space, excepting the little space cleared after excessive pressure has opened the relief valve.

I take exception to Mr. Kirlin's method for two reasons: First, in a four-valve engine it could not be placed near enough to the end of the cylinder, if tapped into the bottom, to do any good during the period of compression, when it is most needed; second, it is likely to give trouble by leakage at the connections, after being used a few years.

I would much prefer to have relief valves tapped directly into the counterbore, through the side of the cylinder. This custom is adopted by most engine builders and gives universal satisfaction. If Mr. Kirlin placed his relief valves in an inverted position underneath the cylinder, he would find adjusting and repairing a disagreeable job, unless the cylinder was overhung and placed some distance above the floor.

GEORGE R. WILLIAMS.

Findlay, O.

Will an Isolated Plant Pay?

There has lately been much discussion of the above query in the columns of POWER. As I have had some experience with the encroachment of the central station upon the field of the operating engineer, I will add my quota to the general debate. Personally I am of the opinion that even diminutive isolated plants pay; and where they do not compare favorably with purchased power, I believe the fault to lie in the ignorance and stupidity of the attendant engineers. Some years ago I was hired to care for a 25-kilowatt motor which the central station had installed to supplant a little 20-horsepower Atlas slide-valve engine. The old engineer was afraid of electric power, and the superintendent of the mill was blissfully ignorant as to its simplicity and imagined that he had to have an experienced central-station man to operate the machine, which, by the way, was an old Edison bipolar motor, whose only apparent imperfection was a tendency of the commutator and the adjacent bearing to heat up. It ran, otherwise, very nicely; and the power soon became popular with management and operatives alike.

But early one morning the motor stopped; something was wrong with the transmission lines; and over the telephone came the cheering news that the power would be shut off for the rest of the day. Now the mill was behind with its orders, and a delay of even one hour's duration would be seriously felt. If all prospective patrons of power stations could have heard our manager's vehement denouncement of the service that day, it would not now be necessary to propound the above interrogatory caption.

To change from the motor to the engine took some little time, for additions had to be spliced to the main belt, and several pulleys had to be changed; but I was elated at the prospect of running the little engine, though I had, up till then, never seen it in service. They said that she had a habit of lying down on her job, but I was confident that I had located and eliminated its "hook worm," for, while working with it when it lay idle, I had discovered the eccentric advanced so far that the port was over half open for lead. And my suppositions as to the performance of the engine were verified; it bore its load as steadily as the motor had carried it, and at a less expense. I am unable at this late date to give comparative costs of operation in detail, but I do remember well that the saving for the first month was $16, for it was the means of bestowing upon me my first case of swelled head in engineering.

But the point I started in to illustrate and impress upon the reader is that the central station could never have endangered the engineer's job in this mill, had the engineer himself been competent. Hairs may be split as to the proper method of balancing charges, interest, etc.; but it should not be forgotten that the engineer is the man who is responsible for the largest items of expense—such items as cannot be juggled by the central-station experts. If a plant is already installed in a building and the engineer loses his job through the crowding out of the central station, I am of the opinion that he deserves losing it. An excellent idea for those who would fight against the encroachments of the central station would be to unite into a society, and vote to levy assessments for the support of experts, whose duty it shall be to visit such plants as are threatened, and make sure that the encroachment is not warranted by the incompetency of the operating engineer.

C. HUGHES.

Saxonville, Mass.

Holly System for Draining Manifold

In answer to the question asked by Mr. Bopp as to the practicability of the Holly system for draining a manifold collecting drips from separators, reheaters, etc., I wish to say that the Holly system will work if Mr. Bopp will connect a ½-inch equalizing pipe from the header to the receiving tank or manifold, if it is large enough to be used as a receiver.

The riser should be 1½- or 2-inch pipe, depending on the amount of condensation, and the separating tank should be 35 feet above the water line of the boilers. A check valve should also be placed at each boiler in the return line. The turns in the riser should be made by long bends and all valves should be gate or straight way. The vent pipe from the separating tank should be ¾ inch with a good valve near the lower end and should connect with the exhaust pipe or heater. At the present time I am in charge as assistant in a plant using the Holly system under conditions similar to those outlined by Mr. Bopp.

J. C. HAWKINS.

Hyattsville, Md.

Binding "Power"

I am much interested in the methods used by many in binding copies of POWER. This is how I do it. I got my idea from our daily report-sheet file. One day while in the superintendent's office I saw several catalogs which were made up of loose sheets and bulletins placed in substantial covers and held together by two pins or keys passing through the covers and through the holes in the back margin of the leaves. I found several sizes. Some, however, were just the size for such papers as POWER, *Practical Engineer, American Machinist* and other magazines of like dimensions. I selected a set of covers to fit POWER. Before binding the papers, I removed the covers, binding wires and advertising matter. Then I took the pages of reading matter out of each issue that I most desired to save, and punched holes in the back margin, using a templet and belt punch. I put them in place and then tightly bound them down.

As the book was made up of several magazines, I could not use the page numbers as printed, but numbered them from 1 to 700, which was the size of my file. An index was made of the names of the articles and their page numbers, and they were grouped under such heads as New Power Plants, Boiler Management, Boiler Tests and Testing Apparatus, Pumps, Condensers and Connections, Engine Design and Theory, Engine Management, Power Plant Management and Economical Operation, and Gas Engines. Some articles which contained matter coming under more than one head were listed under two or three heads. The list was then typewritten and pasted inside the front cover. The cost of this file was nothing except a little time. It is easily worth $5, perhaps more. A slip of paper pasted on the front cover gives the dates of the first and last number the file includes. My file covers six months.

One objection to binding the whole magazine is that where several papers are taken, there are often articles which are nearly the same, so that the file contains much duplicate matter. Such a method makes a bulky file and handling for reference difficult. I file only those articles which present a new thought or new phase of a subject or one that is of especial interest. Selections from several magazines makes quite a large volume. After reading the articles, I mark those I wish to save and mark their classification. Then when I am ready to do the binding I take the paper apart and remove the pages marked. These loose-leaf binders can be bought for a nominal sum, but I would advise going to the superintendent first. While there are very few dull pages between the covers of such magazines as POWER, *Electrical World, Practical Engineer* and others of the same nature, I do not like to waste time looking through several bulky volumes to find something on a certain subject.

J. CASE.

Hyattsville, Md.

Belt Lacing

In the February 28 number, Thomas Clark asks for information on belt lacing, and as there have not been many replies, I submit the following for his consideration:

Some of the sketches and descriptive material below I have written up in the past, and some of the illustrations shown I have copied from sketches found in a power-plant office in this city. None of the methods shown are considered fancy lacing, but for durability and efficiency they are all right.

The lacing shown in Fig. 1 is known as the hinge joint. It is all right to use on small pulleys at high speeds. Heavier work demands a joint of which Fig. 2 is an example. In making the joint shown in Fig. 2, lace the outside holes first; the pulley side of the belt will show four short and three long straight lines. Fig. 3 is a good all-round joint; the lacing is started at *A A* and finishes at *E E*.

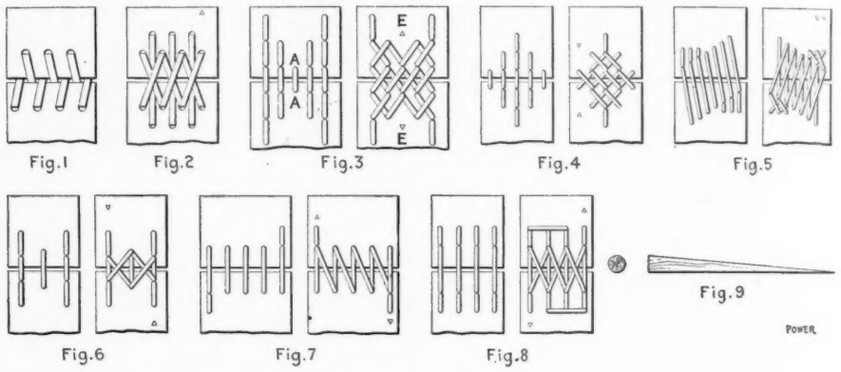


Fig.1 Fig.2 Fig.3 Fig.4 Fig.5

Fig.6 Fig.7 Fig.8 Fig.9

Fig. 4 is often used and Fig. 5 is generally used on quarter-turn work. For small belts running at average speeds, use the method shown in Fig. 6. Figs. 7 and 8 are methods used for light and heavy work.

Fig. 9 is a valuable tool to have on hand when lacing belts. If the lace hole is too tight, it is an easy matter to insert the point of the tool in the hole and start the lace through, and if the tool is used carefully, it will not injure the belt.

Belt ends should be cut off squarely and the holes punched exactly opposite each other; the first row on one end should be opposite the first row on the other end, and so on. Many prefer to cement belt ends instead of lacing, but this has the disadvantage of rendering the taking up of stretch or slack a difficult matter.

JAMES E. NOBLE.

Toronto, Can.

Stopping a Pound

C. B. Smith's article in the April 25 issue on the reduction of lead and compression, induces me to tell how I increased the output and decreased the coal consumption.

Some time back I was employed in a plant which had one 26x48-inch single-eccentric noncondensing Corliss engine running 90 revolutions per minute. I was told when I took charge that the engine was very much overloaded and that it had a very loud pound but that I was not to let that worry me as there had been two men from the factory trying to locate the cause but had gone away in disgust.

The boilers carried 125 pounds of steam and whenever the steam went below 115 pounds the engine would hook up and the feed from the mill would have to be removed until 125 pounds could be maintained. The engine is five years old and has had two new crank pins.

I applied my indicator and found that the compression started when the piston had made two-thirds of the stroke, which carried it up to about 75 pounds. I cut the compression down one-half but still the pound was not affected. It could be heard for a block around. I had several indicator experts come out to take cards and they all claimed that the conditions could not be improved.

I noticed that the higher the boiler pressure the louder the knock, but still I thought the indicator showed a good admission line. I decided something must be done, so I gave my steam valve enough lap to let the piston travel about one inch before the valves opened. This stopped the pound instantly and the engine began to run as smooth as any engine in the city. The load that it previously carried with 125 pounds of steam can be carried nicely now with 100 pounds. Today the engine pulls the same load with a one-quarter cutoff that a three-eighths cutoff would not handle when I took charge. Thus by removing the compression the engine developed considerably more power.

J. W. DICKSON.

Memphis, Tenn.

Issued Weekly by the
Hill Publishing Company
JOHN A. HILL, Pres. and Treas. ROB'T MCKEAN, Sec'y.
505 Pearl Street, New York.
122 South Michigan Boulevard, Chicago.
6 Bouverie Street, London, E. C.
Unter den Linden 71—Berlin, N. W. 7.

Correspondence suitable for the columns of POWER solicited and paid for. Name and address of correspondents must be given—not necessarily for publication.

Subscription price $2 per year, in advance, to any post office in the United States or the possessions of the United States and Mexico. $3 to Canada. $5 to any other foreign country.

Pay no money to solicitors or agents unless they can show letters of authorization from this office.

Subscribers in Great Britain, Europe and the British Colonies in the Eastern Hemisphere may send their subscriptions to the London Office. Price 21 Shillings.

Entered as second class matter, December 20, 1910, at the post office at New York, New York, under the Act of March 3, 1879.

Cable address, "POWPUB," N. Y.
Business Telegraph Code.

CIRCULATION STATEMENT

Of this issue, 35,000 copies are printed.

None sent free regularly, no returns from news companies, no back numbers. Figures are live, net circulation.

Contents

PAGE

New Power Plant of Dennison Mfg. Co.. 752
License Agitation in Rhode Island..... 756
Overcoming Shortage in Feed Water.... 757
The Old Mill at New London, Conn..... 758
Boiler Room Bulletin..... 759
Captain Charles H. Manning..... 760
Desirable Improvements in Boilers..... 761
Smokestacks for Natural Draft..... 763
Oil Fuel for Steam Boilers..... 764
Some Ingenious Engine Room Kinks..... 767
Automatic Starting Attachment for an Exciter 769
An East Indian Postgraduate Technical School 770
Small Station Switchboards..... 770
Substitute for a Double-throw Switch... 771
An Extension Brush Holder..... 771
Starting a Large Motor Supplied by a Small Alternator 771
Running a Gasolene Engine with Kerosene 772
Steam Engineers for Gas Power Plants 773
Essential Factors in Making Producer Gas 774
An Airtight Peephole..... 774
Practical Letters:
Inspirator Troubles .... Flywheel Worked Loose....Some Power Cost Figures .... Smoke Preventers .... Regrinding a Safety Valve....Babbitting Bearings .... Repairing a Broken Pump Gland.....775-777
Discussion Letters:
A System of Lubrication .... The Point of View....Constant Receiver Pressure .... Unnecessary Clearance Loss....Will an Isolated Plant Pay? ....Holly System for Draining Manifold .... Binding "Power" .... Belt Lacing....Stopping a Pound.....778-780
Editorials 781-782
Capacity of Ammonia Compressors..... 784
A Case of Frosting..... 787

POWER

Some Argument Figures

When a central-station man undertakes to prove that an isolated plant has really no excuse for existence, or an isolated-plant man starts in on an exposition of central-station iniquities, or a gas-engine man presents a few "representative" comparisons with steam, or a—well, when figures are dug up by anybody to support a commercial contention those figures nearly always have a weird, unnatural aspect. The old, old characteristic of zealotry comes right to the front with forefeet stuck deep in the sand and hind feet combatively elevated. Sometimes, of course, the figurer has a forlorn hope to defend and his plight seems to demand heroic measures, but in many cases the bare, unbolstered truth is ample and would be infinitely more effective than a strained version.

An instance of the latter sort of "case" is printed in a recent number of the National Electric Light Association *Bulletin.* A storage-battery man, obviously with a view to presenting an invulnerable argument for the electric truck as against the gasolene truck, puts the cost of charging the battery at one cent per kilowatt-hour. Now, although that figure may be correct for the specific truck and generating plant to which he referred, we all know perfectly well not only that one cent per kilowatt-hour is not a representative figure but that there are not a dozen charging stations in the entire country that can generate their energy at that cost, let alone sell it for that. Where, then, is the sense in quoting this rate in a letter purporting to present a general comparison? The electric truck has so many real advantages over the gasolene-motor truck for use within the radius of any city in this country and the operating costs of the two are so nearly alike that a discussion of the latter is a waste of time and a forced favorable showing for the electric is more harmful than otherwise.

An amusing manifestation of inconsistency was made recently by our esteemed contemporary the *Electrical Review and Western Electrician.* In an effort to show that isolated-plant costs are higher than central-station rates, the *Review* said editorially that a certain isolated plant powered by three gas engines of forty horsepower each showed the woefully high operating cost of something like three or four cents per kilowatt-hour. Some of the figures on which this contention was based were absurdly high and unrepresentative, but the amusing feature of the case is that the *Review's* editorial assertions and assumptions were completely refuted by the report of a producer-gas-power central station published in the same issue with the editorial. Although the isolated plant of one hundred and twenty horsepower could not get its cost below three cents, the central station, which was of only eighty horsepower capacity, easily showed less than two cents per kilowatt-hour!

The explanation is simple. The fixed charges and fuel cost ascribed to the isolated plant were abnormally high, whereas the fixed charges for the central-station plant were too low and the costs of administration, of transmitting power to the consumer and of keeping lines in condition were ignored.

An Uphill Fight

It is always desirable to know the actual cost of power being delivered from any plant. The advantages to be derived from this knowledge are too obvious to require explanation. It is frequently the lack of this information in convenient form which enables the central station to take over the plant and reduce the importance of the installation to one required merely for heating.

On the other hand, many a winning fight has been conducted using well arranged operating records as an argument, the significance of which the owner could not fail to appreciate. When the matter is one merely of dollars and cents, it is not so very difficult for the well informed engineer to carry the fight into the enemy's country and present his side of the case with some show of success.

There is another feature in this controversy, however, against which the operating engineer finds himself well nigh powerless to contend. This is one of high finance and does not relate to the actual money involved in any local situation, but has more to do with the interests which control the different projects requiring power. Moneyed men have affiliations which are not apparent on the surface; they play billiards at the same club; they go hunting and fishing together, and have associations which result in mutual benefit in many ways, and which influence them to make decisions that to the outsider would indicate poor business judgment.

There is a group of buildings in the business district of a Western city, all taking central-station current and paying from five to eleven cents per kilowatt-hour. The chief engineer of this property, a capable man, has repeatedly brought to the attention of the owner that concentrating the several different heating plants necessary to take care of these buildings and generating current at a central point, using the exhaust steam for heating, would result in a net saving of twenty thousand dollars a year, but this has had no effect.

It would seem to the ordinary individual that the owner, although already a multimillionaire, could afford to take the trouble to pick up this extra money. It may easily be possible, however, that he can well afford to pay twenty thousand dollars a year for the privilege of sitting in the same game with the financial powers that be, the benefits of this being far greater (to him) than any petty saving which might accrue from changes recommended in his power department.

Against this sort of competition the operating engineer is working under a serious handicap. It illustrates the necessity of being wide awake in every respect and emphasizes the importance of having every scrap of available information at hand, ready to use at the proper time.

If the engineer knows, he has a chance. If he does not know, he is lost.

Slovenly Language and Salary

As we have said before, it is neither necessary nor to be expected that an engineer shall be a shining literary light or even a polished writer or speaker. It *is* important, however, that engineers should use language which means what they intend it to mean and refrain from inflicting upon more careful people a mongrel jargon unworthy of the intellect of a scavenger's assistant. Electrical engineers and artisans appear to be more reckless in this respect than other technicians. A common specimen of inaccuracy is the use of the word "kilowatt" alone when "kilowatt-hour" is meant. This is not inelegant, of course; it is merely an indication of either ignorance or carelessness. A kilowatt is very far from being a kilowatt-hour; it has to exist exactly sixty minutes before it represents a kilowatt-hour. It is highly probable that every reader of POWER knows that simple fact. It is almost as probable that many of them would unhesitatingly say that the cost of "current" is so many cents "per kilowatt," which is absolutely devoid of intrinsic meaning. Such a statement is usually understood by those familiar with the sloppy habit of speech, but that is no excuse for it. Current is neither power nor energy and power is not energy and has no value until it is combined with time to make energy. A similar carelessness characterizes references to horsepower, the word being used alone when "horsepower-hour" is meant.

The haphazard use of the word "field" is another common cause of confusion and mental irritation. In electrical engineering the word has exactly one meaning, no more. A field magnet is not a "field"; neither is a magnet coil, nor is a yoke ring, nor yet the exciting current. Nevertheless, all of these are frequently referred to as the "field" by men who either ought to or do know better. Both of these editorial pages could be filled with such citations.

Now there is no direct relation between exactness of speech and earning power, except in literary work. But there is a very strong indirect relation in all other kinds of skilled work. A man who is careful in one respect is very likely to be careful in others and, although it is not at all probable that the mere avoidance of the class of errors just referred to will produce an immediate increase in salary, it is almost certain that cultivating the habit of accuracy—not hair splitting—will ultimately increase one's value to his employer. A certain electrical engineer has a knowledge of his particular branch of the science that should enable him to earn a very large salary. The fact is, however, that he is so slovenly in the application of his knowledge that other men who have less are drawing larger salaries because of their greater accuracy. The inaccuracy of this man is reflected in his every utterance; "power" is always "current" with him; "reactance" is "self-induction," and everything about a machine except the armature and bearings is referred to indiscriminately as the "field"—and so on, down the whole list.

Absurdities of a School of Finance

The school of finance and commerce attached to one of our large universities requires neither scientific nor engineering knowledge from its students at entrance and does not teach either of these branches in its courses. It is, therefore, astonishing that last December the school required each student to separately select a manufacturing plant and make a series of reports thereon.

The first report was to be a careful study of the power plant, its installation, cost of production and cost of distribution, involving a number of drawings and a careful discussion of the suitability of the power equipment for the particular plant, comparing it with other possible sources of power.

This was to be followed by a second report dealing with the raw material, its storage and handling. A third report was to relate to superintendence, organization, management, labor payment and inspection, the students to suggest improvements and give reasons therefor. A discussion upon storing, shipping and selling the finished product was next in order, and, finally, a report was to be made upon "cost keeping."

The average student taking this course has no conception of foot-pounds; he could not define a horsepower, and would be unable to distinguish between boiler, engine and electrical horsepowers. He has probably never heard of a B.t.u. and knows absolutely nothing about the burning of fuel and the cost of power production. He has never installed a power plant; knows nothing of its power, and has not had sufficient experience to estimate depreciation. Yet his teacher, advancing these tasks, believes these facts can be obtained by merely "observing" and asking a few judicious questions.

How can an untrained mind observe fuel costs, capital costs, repairs, etc.? These are not elements of observation, but matters of experience and operation. Moreover, to whom shall the student address "a few judicious questions"? If he obtains any information at all, is he sure that his information is correct, and how can he check it? As to cost keeping, even though he has access to the books and accounts of a particular plant; it would require many weeks for him to go over the vouchers, for, say, the past year, and ascertain whether or not the accounts were properly and correctly kept. Yet this student is to advise as to the adaptability of the system of bookkeeping and to make suggestions as to improvements.

Such a course is incongruous and serves as a testimonial to the impracticability of those responsible for it. If certain schools would confine their efforts to the fields which they can legitimately cover and not attempt things out of their sphere, technical education would be better served and there would be fewer instances of its being subjected to ridicule by the practical man.

If a man tried to sell a 1000-horsepower Corliss engine for five hundred dollars, any of us would naturally ask him what was the matter with it. Why do not all of us do that when another man offers to sell cylinder oil at eleven cents a gallon?

When you reach the conclusion that you are too big for your job, it is a safe plan to take a vote and see how nearly unanimous that opinion is before you shake the dust of that job off your feet and tackle a bigger one.

After all is said and done, do you really believe there is any good excuse for a modern dynamo or motor to spark at the brushes? We don't.

Inquiries of General Interest

Questions are not answered unless accompanied by the name and address of the inquirer. This page is for you when stuck—use it

Bucket Pump Defined

What is a bucket pump?

B. P. D.

A bucket pump is one in which the water passes through the piston as in the common house pump or as in the vertical single-acting jet-condenser air pump.

Vacuum in Simple and Compound Engines

Which requires the higher vacuum, a simple or a compound engine?

S. C. E.

There is no difference in the requirements except as regards economical operation, but it is customary to carry a higher vacuum with a compound than with a simple engine, as it is believed that it is more economical not to employ so high a vacuum in simple engines on account of the difference of temperature between the entering and the exhaust steam in the simple engine, which is much greater than in the low-pressure cylinder of the compound engine and nullifies the gain of a reduced back pressure by initial condensation.

Flared Tube Ends

Why are the tube ends of water-tube boilers flared instead of being beaded?

L. H. F.

Tubes are flared because it is easier, cheaper and just as effective as beading for the purpose intended.

Variation in Air Pump Piston Speed

Why does the piston of an air pump start off fast and slow down near the end of the stroke?

P. C. V.

In the independent steam-operated direct-acting air pump the cylinder at the beginning of the stroke contains a little water and also air at the pressure existing in the condenser. At the beginning of the stroke the piston meets with little resistance and, until the air is compressed to nearly atmospheric pressure, the motion of the piston is rapid. As the pressure in the cylinder rises the speed is reduced and is slowest as the water and the air are being forced out through the discharge valves.

Hydrostatic Test and Yield Point

If the bursting pressure of a boiler shell is 600 pounds per square inch and the yield point is one-half the tensile strength, what hydrostatic pressure would it be safe to apply? What is the rule for finding the yield point?

H. T. P.

If the bursting pressure is 600 pounds per square inch and the yield point is at one-half the tensile strength, then yielding will begin at 300 pounds pressure per square inch. With a factor of safety of five, the working pressure will be 120 pounds, and the hydrostatic test pressure applied 50 per cent. above the working pressure, or 180 pounds, 120 pounds below the yield point, is presumably safe. There is no rule for determining the yield point or elastic limit as it is called. It can only be determined by experiment.

Steam and Air Pressure

If a 4-inch air pipe should be connected to a 4-inch steam pipe with 110 pounds pressure in the air pipe and 100 pounds pressure in the steam pipe, what would happen?

J. J. H.

The air, if the pressure were kept at the original pressure, would force the steam back to the boiler whence it came and increase its pressure to that of the air unless relieved by the blowing of the safety valve.

High-speed Engine Valve Setting

If the valve on a high-speed automatic engine is out of adjustment, how may it be reset?

E. G. M.

In most high-speed automatic engines the only valve setting the engineer can do is that of adjusting the length of the valve stem. The valves are set by lead, which means that the lead is made right for each end of the cylinder. Usually a little more is given on the head than on the crank end.

Gas-engine Efficiency

What is the heat efficiency of a producer-gas engine of a few hundred horsepower?

W. T. McN.

From about 22 to about 27 per cent., according to size and condition.

Steam Table Differences

In the last edition of "Kent's Pocketbook" the value for the latent heat of steam at 212 degrees Fahrenheit is given, in a table compiled by Marks & Davis, as 970.4 B. t.u. The value of 966 is the one I have seen most frequently used. Which is the correct value? Which value is used in engineering work where accuracy is desired?

C. D. H.

Recent investigation has shown that the total heat of saturated steam as given in the old tables was too low, and both the Marks-Davis and the Peabody tables have been revised in accordance with the new values. The Marks-Davis tables are used in this office. Peabody's new value for the latent heat of steam at 212 degrees is 969.7; the difference between this value and that given in the Marks-Davis tables is largely due to the fact that Professor Peabody uses for the value of the B.t.u. the amount of heat necessary to raise a pound of water one degree at 62 degrees while Professors Marks and Davis use the average amount of heat required to change a pound of water one degree through the entire range from 32 to 212.

The Best Size of Wire

How can I determine the best size of wire to use in a long power circuit?

C. T. McK.

From the purely mathematical point of view, the greatest economy is obtained when the value of the energy lost in the line annually is equal to the interest and depreciation charges against the cost of the line. There are practical considerations, however, which cannot be ignored. If the drop in the line is excessive, the voltage regulation at the far end will not be satisfactory; induction motors will not operate properly and it will be difficult to obtain satisfactory results from incandescent lamps because of the variations in candlepower. If the line is an addition to an existing system, the question of regulation takes first place; if it is a question of laying out a new transmission line or building the feeder system of a new plant, maximum operating economy comes first, because the matter of regulation in such cases can usually be provided for by means of special apparatus. The interest and depreciation on such apparatus should be added to that on the line in figuring the maximum-economy conditions.

Refrigeration Department

Principles and operation of ice making and refrigerating plant and machinery

Capacity of Ammonia Compressors

By F. E. Matthews

Since the efficiency of ammonia compressors is subject to wide variations, both through diversity of design and diversity of operating conditions to which the same machine is often subjected, the efficiency of the individual compressor should be determined under its own operating conditions. This can be accomplished most accurately by determining the quantity of refrigerating fluid actually passing through the system and comparing this amount with the apparent amount computed from the displacement of the compressor.

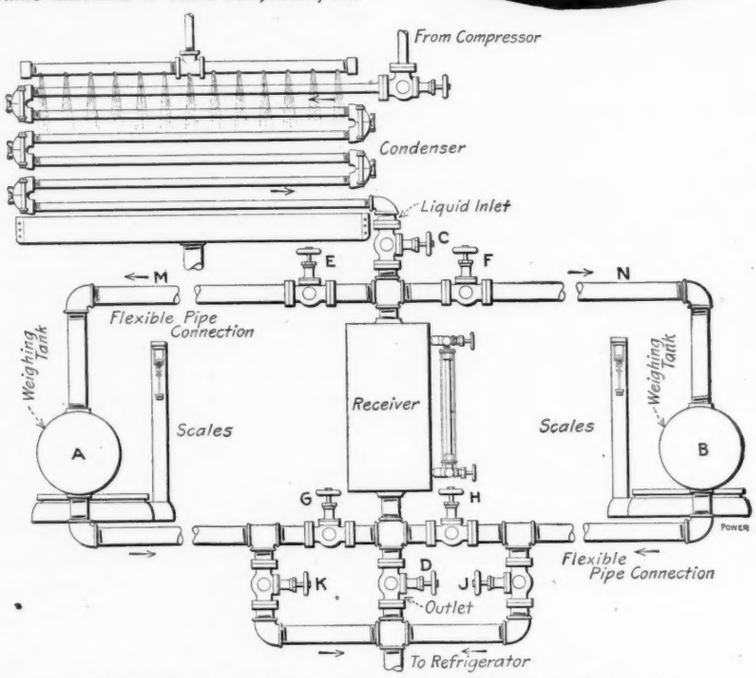


Fig. 1. Arrangement of Piping for Weighing Ammonia

The best way for determining the amount of liquid refrigerant is to weigh it. Fig. 1 represents a condenser, a pair of weighing tanks and their connections. For testing, crosses are inserted in the inlet and outlet lines, and valves and additional pipes are attached as indicated. When using the weighing tanks, the outlet valve *D* is closed or blanked off and, as the valves in the new connections are closed, the liquid refrigerant collects in the receiver. The weighing tank *A* is filled by opening valves *E* and *G*, after which valve *G* is closed and the gross weight of the tank and its contents is determined. The weight of the refrigerant is then found by subtracting the net weight of the tank and the liquid in the bottom connections. While the liquid in tank *A* is being weighed, tank *B* is supplying the cooler through valve *J*. Alternate filling and emptying of the two tanks allow the operation of the plant to proceed without interruption. When employing this method for weighing the refrigerating liquid, it is necessary that the pipes connecting with the weighing tanks be sufficiently long to insure flexibility to the system. The liquid level should never be allowed to rise to the pipes *M* and *N*, as any liquid other than that vertically over the drums will not be weighed correctly.

Assume that a test has been conducted under standard conditions and it has been determined that *X* pounds of anhydrous ammonia are evaporated per hour. The number of heat units required to cool a pound of the liquid is

$$S\ (t_1 - t_2) = 1\ (90 - 0) = 90\ B.t.u.$$

The heat units available from the evaporation of one pound of ammonia are

$$R_{B.P.} - S\ (t_1 - t_2) = 555.5 - 90 = 465.5\ B.t.u.$$

The amount of anhydrous ammonia required per ton per minute is

$$\frac{200}{R_{B.P.} - S(t_1 - t_2)} = \frac{200}{465.5} = 0.42964\ pound$$

which is equivalent to 25.778 pounds per hour or 618.7 pounds per day of 24 hours; where

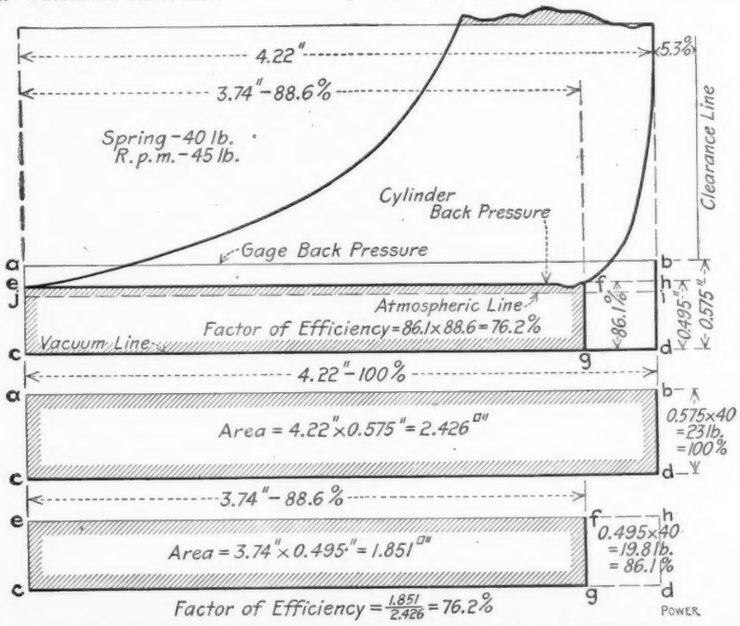


Fig. 2. Graphical Method for Determining Efficiency

TABLE 1. PISTON SPEED OF DOUBLE-ACTING COMPRESSOR IN FEET PER MINUTE.—From *Transactions* of the A. S. M. E.

Length of Stroke in Inches.	Revolutions per Minute.																									
	1	24	26	28	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
1	0.1666	4	4.33	4.66	5	5.16	5.33	5.5	5.66	5.83	6	6.16	6.33	6.5	6.66	6.83	7	7.16	7.33	7.5	7.66	7.83	8	8.16	8.33
2	0.333	8	8.66	9.33	10	10.33	10.66	11	11.33	11.66	12	12.33	12.66	13	13.33	13.66	14	14.33	14.66	15	15.33	15.66	16	16.33	16.66
4	0.666	16	17.33	18.66	20	20.66	21.33	22	22.66	23.33	24	24.66	25.33	26	26.66	27.33	28	28.66	29.33	30	30.66	31.33	32	32.66	33.33
6	1	24	26	28	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
8	1.333	32	34.66	37.33	40	41.33	42.66	44	45.33	46.66	48	49.33	50.66	52	53.33	54.66	56	57.33	58.66	60	61.33	62.66	64	65.33	66.66
9	1.5	36	39	42	45	46.56	48	49.5	51	52.5	54	55.5	57	58.5	60	61.5	63	64.5	66	67.5	69	70.5	72	73.5	75
10	1.666	40	43.33	46.66	50	51.66	53.33	55	56.66	58.33	60	61.66	63.33	65	66.66	68.33	70	71.66	73.33	75	76.66	78.33	80	81.66	83.33
11	1.833	44	47.66	51.33	55	56.83	58.66	60.5	62.33	64.16	66	67.83	69.66	71.5	73.33	75.16	77	78.83	80.66	82.5	84.33	86.16	88	89.83	91.66
12	2	48	52	56	60	62	64	66	68	70	72	74	76	78	80	82	84	86	88	90	92	94	96	98	100
13	2.166	52	56.33	60.66	65	67.16	69.33	71.5	73.66	75.83	78	80.16	82.33	84.5	86.66	88.83	91	93.16	95.33	97.5	99.66	101.83	104	106.16	108.33
14	2.333	56	60.66	65.33	70	72.33	74.66	77	79.33	81.66	84	86.33	88.66	91	93.33	95.66	98	100.33	102.66	105	107.33	109.66	112	114.33	116.66
15	2.5	60	65	70	75	77.5	80	82.5	85	87.5	90	92.5	95	97.5	100	102.5	105	107.5	110	112.5	115	117.5	120	122.5	125
16	2.666	64	69.33	74.66	80	82.66	85.33	88	90.66	93.33	96	98.66	101.33	104	106.66	109.33	112	114.66	117.33	120	122.66	125.33	128	130.66	133.33
17	2.833	68	73.66	79.33	85	87.83	90.66	93.5	96.33	99.16	102	104.83	107.66	110.5	113.33	116.16	119	121.83	124.66	127.5	130.33	133.16	136	138.83	141.66
18	3	72	78	84	90	93	96	99	102	105	108	111	114	117	120	123	126	129	132	135	138	141	144	147	150
19	3.166	76	82.33	88.66	95	98.16	101.33	104.5	107.66	110.83	114	117.16	120.33	123.5	126.66	129.83	133	136.16	139.33	142.5	145.66	148.83	152	155.16	158.33
20	3.333	80	86.66	93.33	100	103.33	106.66	110	113.33	116.66	120	123.33	126.66	130	133.33	136.66	140	143.33	146.66	150	153.33	156.66	160	163.32	166.66
22	3.666	88	95.33	102.66	110	113.66	117.33	121	124.66	128.33	132	135.66	139.33	143	146.66	150.33	154	157.66	161.33	165	168.66	172.33	176	179.66	183.33
24	4	96	104	112	120	124	128	132	136	140	144	148	152	156	160	164	168	172	176	180	184	188	192	196	200
26	4.333	104	112.66	121.33	130	134.33	138.66	143	147.33	151.66	156	160.33	164.66	169	173.33	177.66	182	186.33	190.66	195	199.33	203.66	208	212.33	216.66
28	4.666	112	121.33	130.66	140	144.66	149.33	154	158.66	163.33	168	172.66	177.33	182	186.66	191.33	196	200.66	205.33	210	214.66	219.33	224	228.66	233.33
30	5	120	130	140	150	155	160	165	170	175	180	185	190	195	200	205	210	215	220	225	230	235	240	245	250
32	5.333	128	138.66	149.33	160	165.33	170.66	176	181.33	186.66	192	197.33	202.66	208	213.33	218.66	224	229.33	234.66	240	245.33	250.66	256	261.33	266.66
34	5.666	136	147.33	158.66	170	175.66	181.33	187	192.66	198.33	204	209.66	215.33	221	226.66	232.33	238	243.66	249.33	255	260.66	266.33	272	277.66	283.33
36	6	144	156	168	180	186	192	198	204	210	216	222	228	234	240	246	252	258	264	270	276	282	288	294	300
38	6.333	152	164.66	177.33	190	196.33	202.66	209	215.33	221.66	228	234.33	240.66	241	253.33	259.66	266	272.33	278.66	285	291.33	297.66	304	310.33	316.66
40	6.666	160	173.33	186.66	200	206.66	213.33	220	226.66	233.33	240	246.66	253.33	260	266.66	273.33	280	286.66	293.33	300	306.66	313.33	320	326.66	333.33
42	7	168	182	196	210	217	224	231	238	245	252	259	266	273	280	287	294	301	308	315	322	329	336	343	350
44	7.333	176	190.66	205.33	220	227.33	234.66	242	249.33	256.66	264	271.33	278.66	286	293.33	300.66	308	315.33	322.66	330	337.33	344.66	352	359.33	366.66
46	7.666	184	199.33	214.66	230	237.66	245.33	253	260.66	268.33	276	283.66	291.33	299	306.66	314.33	322	329.66	337.33	345	352.66	360.33	368	375.66	383.33
48	8	192	208	224	240	248	256	264	272	280	288	296	304	312	320	328	336	344	352	360	368	376	384	392	400
50	8.333	200	216.66	233.33	250	258.33	266.66	275	283.33	291.66	300	308.33	316.66	325	333.33	341.66	350	358.33	366.66	375	383.33	391.66	400	408.33	416.66
52	8.666	208	225.33	242.66	260	268.66	277.33	286	294.66	303.33	312	320.66	329.33	338	346.66	355.33	364	372.66	381.33	390	398.66	407.33	416	424.66	433.33
54	9	216	234	252	270	279	288	297	306	315	324	333	342	351	360	369	378	386	395	405	414	423	432	441	450
56	9.333	224	242.66	261.33	280	289.33	298.66	308	317.33	326.66	336	345.33	354.66	364	373.33	382.66	392	401.33	410.66	420	429.33	438.66	448	457.33	466.66
58	9.666	232	251.33	270.66	290	299.66	309.33	319	328.66	338.33	348	357.66	367.33	377	386.66	396.33	406	415.66	425.33	435	444.66	454.33	464	473.66	483.33
60	10	240	260	280	300	310	320	330	340	350	360	370	380	390	400	410	420	430	440	450	460	470	480	490	500
62	10.333	248	268.66	289.33	310	320.33	330.66	341	351.33	361.66	372	382.33	392.66	403	413.33	423.66	434	444.33	454.66	465	475.33	485.66	496	506.33	516.66
64	10.666	256	277.33	298.66	320	330.66	341.33	352	362.66	373.33	384	394.66	405.33	416	426.66	437.33	448	458.66	469.33	480	490.66	501.33	512	522.66	533.33
66	11	264	286	308	330	341	352	363	374	385	396	407	418	429	440	451	462	473	484	495	506	517	528	539	550
68	11.333	272	294.66	317.33	340	351.66	362.66	374	385.33	396.66	408	419.33	430.66	442	453.33	464.66	476	487.33	498.66	510	521.33	532.66	544	555.33	566.66
70	11.666	280	303.33	326.66	350	361.66	373.33	385	396.66	408.33	420	431.66	443.33	455	466.66	478.33	490	501.66	513.33	525	536.66	548.33	560	571.66	583.33
72	12	288	312	336	360	372	384	396	408	420	432	444	456	468	480	492	504	516	528	540	552	564	576	588	600

S = Specific heat of liquid ammonia;

t_1 = Temperature of the liquid ammonia;

t_2 = Temperature of the ammonia vapor corresponding to a back pressure of 15.67 pounds gage;

$R_{B.P.}$ = Latent heat of vaporization of ammonia at back pressure, in this case zero degrees Fahrenheit;

200 = Number of heat units per minute corresponding to one ton of refrigeration per 24 hours.

If, for example, it is found by test that 3000 pounds of liquid ammonia per hour pass through a refrigerating system, the compression unit of which is a 19x38-inch double-acting compressor running at 45 revolutions per minute under standard conditions, the cooling effect produced is found to be

$$\frac{3000}{25.778} = 116.37 \text{ tons}$$

The capacity apparently developed is computed from the displacement per minute of the compressor piston. This is represented by the expression

$$D = \frac{\frac{\pi}{4} \times d^2 \times l \times r.p.m. \times 2}{1728}$$

$$D = \frac{0.7854 \times 361 \times 38 \times 45 \times 2}{1728}$$

$$= 561.15 \text{ cubic feet}$$

per minute, where

D = Piston displacement in cubic feet per minute;

d = Diameter of piston in inches;

l = Length of stroke in inches.

The cooling effect per cubic foot of ammonia gas passed through the compressor is found from the expression

$$C = \frac{R_{B.P.} - S(t_1 - t_2)}{V}$$

$$C = \frac{555.5 - 1(90 - 0)}{9.028} = 51.56 \text{ B.t.u.}$$

where,

C = Cooling effect per cubic foot of ammonia;

V = Volume of one pound of the ammonia gas passing through the compressor, cubic feet.

Hence the apparent tonnage capacity is

$$\frac{D \times C}{200} = \frac{561.15 \times 51.56}{200} = 144.66 \text{ tons}$$

Obviously, the efficiency of the compressor can be approximated by dividing the probable cooling effect, as determined by calculation based on the properties of the liquid, by the tonnage computed from the apparent displacement per minute in cubic feet, as calculated from the dimensions of the compressor; hence

$$E = \frac{116.37}{144.66} = 80.4 \text{ per cent.}$$

In the majority of cases the tonnage capacity of the system is required with reasonably close accuracy, but it is often impracticable to weigh the ammonia. In

such cases a somewhat less accurate estimate of the efficiency of the compressor can be made with the assistance of an indicator. For all practical purposes the weight of ammonia gas may be considered proportional to its absolute pressure, and within narrow limits the amount of refrigeration represented by a cubic foot of ammonia gas will likewise be proportional to its absolute pressure. From this it follows that anything tending to reduce either the number of cubic feet of gas that a compressor handles or lower the pressure at which it is handled, proportionately reduces the capacity of the compressor. Graphically this is illustrated and the actual amount of the reduction in capacity is determined as follows:

Having taken an indicator diagram, such as that shown in Fig. 2, draw the lines *a b* and *c d* representing, respectively, the actual back pressure in the suction pipe, as indicated by a gage, and the line of absolute vacuum. Next, determine *f*, the point at which the suction valve first opens to admit cold gas to the compressor cylinder. This point is the intersection of the admission line *e f* and the reëxpansion line forming the heel of the diagram. Draw a vertical line *f g* through this point and other vertical lines *e c* and *b d* through the ends of the diagram. These horizontal and vertical lines form two rectangles. The larger one *a b d c* incloses a smaller one *e h d c* which, in turn, is made up of two still smaller rectangles *e f g c* and *f h d g*.

In the case under consideration the cylinder back-pressure line *a b* scales 4.6 pounds above the atmospheric line *j i*, making the absolute back pressure within the cylinder approximately 19.6 pounds. The observed suction pressure in the suction line is 8 pounds gage or approximately 23 pounds absolute, of which the 19.6 pounds is 86 per cent. This means that on account of the fall in back pressure, in passing through the suction valves and pits in entering the compressor cylinder, each cubic foot of gas represents only 86 per cent. as much ammonia by weight, as it would had no resistance been encountered and the cylinder back pressure had been 23 pounds, the same as in the suction line.

The diagram shows that the compressor from which it was taken had excessive clearance. Due to the reëxpansion of the high-pressure gases remaining in the clearance spaces, the opening of the suction valve is delayed until the piston has reached point *f* in the suction stroke. Cold returning ammonia gas can enter the compressor cylinder only during the time the piston is passing from *f* to the end of its stroke. The full length

TABLE 2. DISPLACEMENT *D* IN CUBIC FEET PER FOOT OF PISTON TRAVEL FOR VARIOUS-SIZED CYLINDERS.

Diameter, Inches and Fractions of Inch.	Cubic Feet per Inch of Piston Travel.				Diameter, Inches and Fractions of Inch.	Cubic Feet per Foot of Piston Travel.			
	0 Inch.	¼ Inch.	½ Inch.	¾ Inch.		0 Inch.	¼ Inch.	½ Inch.	¾ Inch.
1	0.00045	0.00071	0.00102	0.00139	1	0.00540	0.00852	0.01224	0.01668
2	0.00182	0.00230	0.00284	0.00344	2	0.02184	0.02766	0.03408	0.04128
3	0.00409	0.00480	0.00557	0.00639	3	0.04908	0.05760	0.06684	0.07668
4	0.00727	0.00821	0.00920	0.01025	4	0.08724	0.09852	0.11040	0.12300
5	0.01136	0.01253	0.01375	0.01503	5	0.13632	0.15036	0.16500	0.18036
6	0.01636	0.01775	0.01920	0.02071	6	0.19636	0.21300	0.23040	0.24852
7	0.02227	0.02389	0.02557	0.02730	7	0.26724	0.28668	0.30684	0.32760
8	0.02909	0.03094	0.03284	0.03480	8	0.34908	0.37128	0.39408	0.41760
7	0.03682	0.03889	0.04102	0.04321	9	0.44184	0.46668	0.49224	0.51852
10	0.04545	0.04775	0.05011	0.05252	10	0.54540	0.57300	0.60132	0.53024
11	0.05500	0.05752	0.06011	0.06275	11	0.66060	0.69024	0.72132	0.75300
12	0.06545	0.06821	0.07102	0.07389	12	0.78540	0.81850	0.85224	0.88668
13	0.07681	0.07980	0.08283	0.08503	13	0.92172	0.95760	0.99396	1.03116
14	0.08908	0.09229	0.09556	0.09888	14	1.0689	1.10748	1.14672	1.18556
15	0.10226	0.10570	0.10920	0.11275	15	1.2271	1.26840	1.31040	1.35300
16	0.11636	0.12002	0.12374	0.12752	16	1.3963	1.44024	1.48488	1.53021
17	0.13135	0.13525	0.13919	0.14320	17	1.5762	1.62300	1.67028	1.71840
18	0.14726	0.15138	0.15556	0.15979	18	1.7671	1.81650	1.86672	1.91748
19	0.16408	0.16843	0.17283	0.17729	19	1.9689	2.02116	2.07396	2.12748
20	0.18181	0.18638	0.19101	0.19570	20	2.1817	2.13656	2.29212	2.34840
21	0.20044	0.20524	0.21010	0.21501	21	2.4053	2.46288	2.52120	2.58012
22	0.21998	0.22501	0.23010	0.23524	22	2.6397	2.70072	2.76120	2.82280
23	0.24044	0.24569	0.25100	0.25637	23	2.8852	2.94828	3.01200	3.07644
24	0.26180	0.26728	0.27282	0.27842	24	3.1416	3.20736	3.27364	3.34104
25	0.28407	0.28978	0.29555	0.30137	25	3.4088	3.47736	3.54666	3.61644
26	0.30725	0.31319	0.31918	0.32523	26	3.6870	3.75828	3.83016	3.90276
27	0.33134	0.33750	0.34373	0.35000	27	3.9760	4.05000	4.12476	4.20000
28	0.35634	0.36273	0.36918	0.37568	28	4.2760	4.35276	4.43016	4.50816
29	0.38225	0.38886	0.39554	0.40227	29	4.5870	4.66632	4.74648	4.82524
30	0.40906	0.41501	0.42281	0.42977	31	4.9081	4.99092	5.07372	5.15724

TABLE 3. CUBIC FEET *F* AND POUNDS *P* OF AMMONIA PER TON OF REFRIGERATION PER 24 HOURS.

W = Weight per cubic foot. BP = Back pressure.			Head Pressure, Condenser or Gage Pressure and Corresponding Temperature.											
			100 Pounds. 63.5 degrees	110 Pounds. 68 degrees	120 Pounds. 72.6 degrees	130 Pounds. 77.4 degrees	140 Pounds. 80.3 degrees	150 Pounds. 83.8 degrees	160 Pounds. 87.4 degrees	170 Pounds. 90.8 degrees	180 Pounds. 93.8 degrees	190 Pounds. 96.9 degrees	200 Pounds. 100 degrees	Temperature, Degrees Fahrenheit.
W	0.0556	P	0.4159	0.4199	0.4240	0.4284	0.4310	0.4343	0.4376	0.4408	0.4440	0.4470	0.4501	—28.5
BP	0	F	7.482	7.551	7.626	7.703	7.761	7.812	7.870	7.929	7.986	8.041	8.095	
W	0.0133	P	0.4122	0.4160	0.4202	0.4243	0.4271	0.4308	0.4335	0.4366	0.4397	0.4437	0.4458	—17.5
BP	5	F	5.636	5.675	5.732	5.790	5.826	5.878	5.914	5.970	5.999	6.039	6.081	
W	0.0910	P	0.4093	0.4130	0.4171	0.4204	0.4237	0.4271	0.4302	0.4332	0.4363	0.4392	0.4423	— 8.5
BP	10	F	4.502	4.543	4.587	4.625	4.662	4.698	4.733	4.766	4.799	4.833	4.865	
W	0.1083	P	0.4068	0.4106	0.4145	0.4186	0.4211	0.4244	0.4276	0.4288	0.4336	0.4365	0.4394	— 1
BP	15	F	3.756	3.791	3.827	3.866	3.889	3.918	3.948	3.975	4.003	4.030	4.058	
W	0.1258	P	0.4040	0.4077	0.4116	0.4158	0.4182	0.4214	0.4245	0.4275	0.4304	0.4333	0.4362	5.66
BP	20	F	3.211	3.241	3.272	3.305	3.324	3.350	3.375	3.398	3.422	3.444	3.467	
W	0.1429	P	0.4025	0.4062	0.4102	0.4140	0.4167	0.4198	0.4229	0.4258	0.4287	0.4316	0.4345	11.5
BP	25	F	2.819	2.843	2 870	2.898	2.916	2.938	2.959	2.980	3.000	3.020	3.040	
W	0.1600	P	0.4013	0.4049	0.4088	0.4128	0.4152	0.4184	0.4213	0.4243	0.4273	0.4300	0.4329	16.8
BP	30	F	2.507	2.530	2.555	2.580	2.600	2.615	2.633	2.653	2.671	2 687	2.706	
W	0.1766	P	0.3991	0.4028	0.4066	0.4105	0.4130	0.4161	0.4188	0.4220	0.4249	0.4277	0.4305	21.7
BP	35	F	2.260	2.280	2.302	2.925	2.338	2.356	2.373	2.390	2.406	2.422	2.443	
W	0.1941	P	0.3984	0.4020	0.4058	0.4098	0.4122	0.4153	0.4183	0.4211	0.4240	0.4269	0.4296	26.1
BP	40	F	2.052	2.071	2.090	2.111	2.123	2.139	2.155	2.175	2.185	2.200	2.214	

$$F = \frac{144 \times 2000}{W\,[1440\,R_{B.P.} - S\,(t_1 - t_2)]} \qquad P = \frac{144 \times 2000}{1440\,R_{B.P.} - S\,(t_1 - t_2)}$$

of the diagram represents the full stroke of the piston and a displacement of 100 per cent. of the full volume of the cylinder. In this case, however, 11.4 per cent. of the volume is occupied by re-expanding hot gas which reduces the amount of cold gas that can enter the compressor to 88.6 per cent. In other words, the actual displacement of the compressor in cubic feet is only 88.6 per cent. of the apparent displacement, based on the cylinder dimensions only.

Now, the 88.6 per cent. of the gas discharged weighs only 86.1 per cent. as much as indicated by the pressure gage on the suction line, so that the number of pounds of ammonia actually discharged by the compressor was only 88.6 × 86.1 per cent. of what would be discharged by a compressor in which there is no clearance or resistance offered to the gas in passing through the suction valves.

Graphically, the length *a b* of the large rectangle *a b d c* represents the compressor cylinder volume, and the hight *b d* the absolute suction-gas pressure in the return line outside the compressor. The product of *a b* and *b d*, or cubic feet and weight per cubic foot—since the weight of a gas depends upon the absolute pressure—represents the apparent displacement per stroke in pounds.

The length *e f* of the small rectangle *e f g c* represents that part of the compressor-cylinder volume filled by the cold gas; and the hight *g f*, the absolute suction pressure within the cylinder. The product of *e f* and *g f* represents the *actual* displacement per stroke in pounds, or the apparent displacement minus the reëxpanded hot gas represented by the rectangle *f h d g*.

The displacement efficiency of the compressor is represented by the ratio of the area of the small to the large rectangle and will be found to be numerically equal to 76.2 per cent. regardless of the units employed in measuring the areas,

$$\frac{3.74 \times 0.495}{4.22 \times 0.575} = \frac{1.851}{2.426} = 76.2 \text{ per cent.}$$

or using pounds to per cent.

$$\frac{19.6 \times 88.6}{23 \times 100} = 76.2 \text{ per cent.}$$

The apparent number of cubic feet of ammonia gas discharged per minute by a 19x38-inch double-acting compressor running at 45 revolutions per minute has already been found to be 561.15. If it is found, by the indicator-diagram method just described, that the displacement efficiency is 76.2 per cent., the actual number of cubic feet discharged will be

$$0.762 \times 561.15 = 427.59 \text{ cubic feet}$$

which, multiplied by the number of British thermal units of refrigeration represented in each cubic foot of ammonia gas actually displaced gives the total cooling effect of the machine expressed in British thermal units per minute. This quantity divided by 200 reduces the capacity to tons per 24 hours. Under standard conditions the number of British thermal units per cubic foot was found above to be 51.56, and, under standard conditions, the tonnage capacity of the compressor under consideration when operating at the determined efficiency of 76.2 per cent. is

$$\frac{561.15 \times 0.762 \times 51.56}{200} = 110.23 \text{ tons}$$

per 24 hours.

To expedite the figuring of capacities, not only under standard but also under other conditions, the accompanying tables of constants have been derived. To determine the tonnage capacity of a double-acting compressor of any size operating at any piston speed and under various conditions of head and back pressure it is necessary only to substitute appropriate values from these tables in the following equations.

Since 200 B.t.u. per minute is the equivalent of one ton per 24 hours, the tonnage capacity *T* of a compressor will be equal to the number of cubic feet of gas *D* actually displaced per minute multiplied by the number of British thermal units of cooling effect *H* available per cubic foot of gas actually displaced, divided by 200. But the actual displacement is equal to the apparent displacement *D* (figured from the dimensions and speed of the machine) multiplied by *E*, the displacement efficiency of the compressor, which may be assumed either from knowledge of the design, calculated from the indicator diagrams or determined by weighing the liquid refrigerant according to the method already described. Expressed as an equation, this becomes

$$T = \frac{HDE}{200}$$

or since $\frac{200}{H}$ represents the cubic feet required per ton

$$T = \frac{DE}{\text{cubic feet required per ton}}$$

but

$$D = \frac{\frac{\pi}{4} \times d^2 \times l \times \text{r.p.m.} \times 2}{1728} =$$

$$d^2 \text{ piston speed } 0.00545418$$

from which the displacement can be computed readily when the diameter of the cylinder and the piston speed are known. The piston speed of a double-acting compressor of a given length of stroke, when operating at a given number of revolutions per minute, may be determined directly from Table 1.

It is also obvious that the apparent displacement is equal to the displacement per foot of piston travel multiplied by the number of feet of piston travel per minute. Table 2 gives this displacement per foot of piston travel, and Table 3 the number of cubic feet of ammonia that must be actually displaced per minute by the compressor to produce refrigeration at the rate of one ton per 24 hours.

Example: The capacity of a 19x38-inch double-acting compressor of 76.19 per cent. displacement efficiency operating at 45 revolutions per minute under 168 pounds head and 16 pounds back pressure is

$$T = \frac{\left\{\begin{array}{c}\text{Piston speed from}\\ \text{Table 1} = 285\\ \text{feet per minute}\end{array}\right\} \times \left\{\begin{array}{c}\text{Apparent displacement}\\ \text{per foot of piston}\\ \text{travel from Table 2}\\ = 1.969 \text{ cubic feet}\end{array}\right\} \times \left\{\begin{array}{c}\text{Displacement efficiency of compressor} = 0.762\end{array}\right\}}{\text{Cubic feet per minute per ton per 24 hours from Table 3} = 3.85} = 111 \text{ tons}$$

A Case of Frosting

Of two vertical single-acting inclosed-crank-case ammonia compressors, one gives trouble by frosting all over the base of the crank case and water jacket; the other does not frost. A ¾-inch pipe with a valve connects the base of the compressor that frosts to the suction line. The valve is left open to prevent the accumulation of pressure in the crank case which forces the oil out through the shaft stuffing box. If the boxes run tight enough to prevent this, it heats. The frost melts off when the valve is closed. What causes the trouble? Does the high-pressure gas get by the piston into the base?

It would appear that liquid ammonia is entering the base of the frosting compressor through the pipe connecting the base to the suction line. This would happen if the connection is made into the bottom of the suction line and the system is so operated that the latter is covered heavily with frost at the point where the connection is made. A small amount of liquid ammonia is sufficient to keep the base of a machine frosted over for a long time, as the absorption of heat through the heavy cast-iron walls is slow and the coating of frost offers still further resistance.

The necessity of running with the valve in the connecting line open is probably due to leakage of high-pressure gas by the piston into the base.

A new set of piston rings carefully fitted might help some, but the better remedy is to so place the equalizing pipe from the base to the suction that any liquid running at the bottom of this pipe cannot drop into the base of the machine. The equalizing pipe is absolutely necessary.

It may be that the suction line to the other compressor is so located that the liquid cannot reach it. If the equalizing line to the second compressor is attached in the same way, the liquid would also drop into the bed of this compressor and cause frosting.

New Power House Equipment

What the inventor and the manufacturer are doing to save time and money in the engine room and power house. Engine room news

"Hydromatic" Water Valve

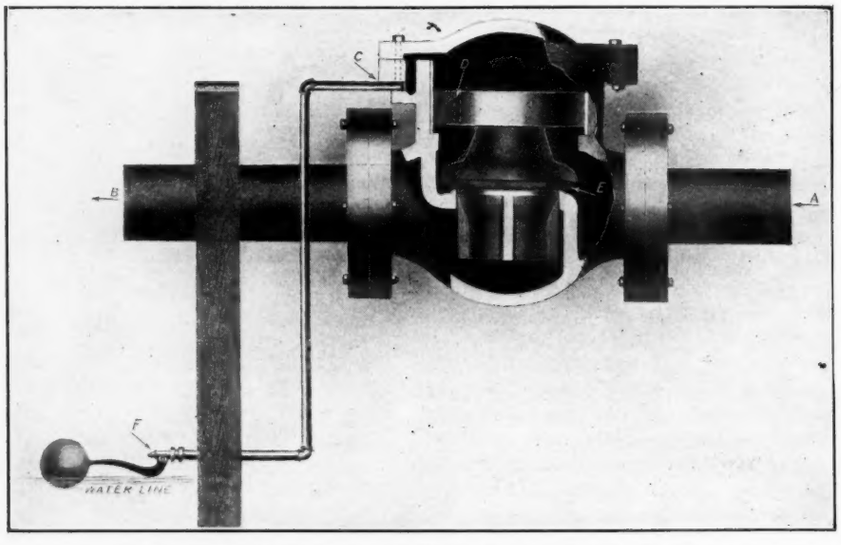
The "Hydromatic" water valve consists of a cast-iron body, a cast-iron cover plate and a brass plunger which is made in two parts. The lower part is screwed into the upper and holds a rubber ring *E*—or where required for hot water, a lead ring—which seats in the valve body, making a tight shutoff when the plunger is down.

The brass plunger travels in a brass bushing, and is fitted into it with a piston fit, requiring no packing. Small tapered holes *D* are drilled into the top of the plunger with a capacity for building up head pressure according to the size of the valve. Into the head of the valve above the plunger is tapped a ¼-inch hole, and from this a ¼-inch pipe leads to a pilot valve *F*, at the water level. This valve is controlled by the operation of a seamless-copper 5-inch float.

When the water in a tank reaches the required hight shown by the location of the pilot valve, the elevation of the float closes the valve and shuts off the vent through the ¼-inch pipe. A head pressure is thereby built up through holes in the top of the plunger, strong enough to force the plunger down and shut off the flow of water through the valve. As water is withdrawn from the tank, permitting the float to drop, the pilot valve *F* is opened and the head pressure on the plunger is released just enough to permit the flow of water to restore sufficiently the required level in the tank. The water entering at *A* and passing between the rubber ring and valve seat, passes down around the ribbed valve to the outlet.

The valve is very sensitive in its action and permits a small inflow of water or a large inflow of the total capacity of the intake pipe, according to the amount of water withdrawn from the tank.

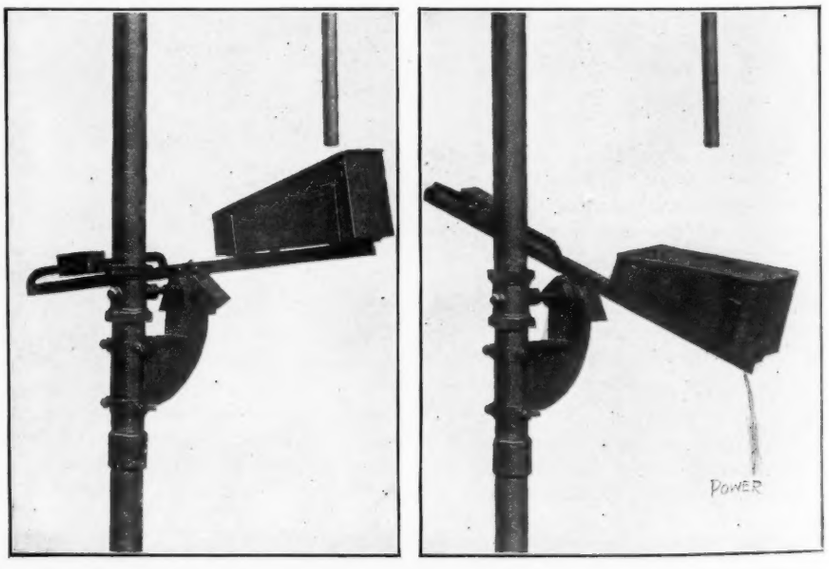
This valve can be used for maintaining water level in tanks, vats, laundry tubs, cisterns, open feed-water heaters, water towers and for a quick opening or closing of a large water main. This may be accomplished by closing the valve in the ¼-inch pipe, which instantly shuts off the flow of water in the main pipe; the opening of the valve in the ¼-inch pipe instantly starts the flow of water. The shutoff valve in this ¼-inch pipe may be placed any distance from the hydromatic value, as long as the hight of the ¼-inch pipe above the hydromatic valve does not create a water pressure per square inch greater than that exerted by water in the main pipe. This device is manufactured by the Cleveland Steel Tool Company, Cleveland, O.



SHOWING DETAILS OF THE HYDROMATIC WATER VALVE

Miller Automatic Water Controller

This device has been designed to economically handle the distilled water in an ice plant and assists in making pure ice, free from oil and the objectionable red core. The device is illustrated and its action described herewith. A small amount of waste water from the skimmer fills the pan, causing it to drop down a few inches and rotate the valve stem, thus opening the valve.



SHOWING AUTOMATIC WATER CONTROLLER IN TWO POSITIONS

A shaft is made to slip on over the end of the valve stem (locked there by a pin and slot), and also serves as a pivot on which the rocker arm rotates. On one end of the rocker arm is an adjustable weight and on the other end a small pan with a hole in the bottom near the outer end. This allows the water to flow from the reboiler into the storage tank.

After the water in the reboiler has been lowered an inch or so, the pan returns to its normal position by the action of the counterweight.

This closes the valve, which remains closed until the reboiler is again full and goes to skimming, thus causing the hot distilled water to stay in the cooling coil long enough to get the full benefit of the cooling water. The process is repeated every few minutes.

The device is free from complicated mechanism and can be installed anywhere between the reboiler and the storage tank and keeps the water sweet and the ice clear.

It is manufactured by L. G. Miller & Sons, 237 Gordon street, Jackson, Tenn.

Bradford Automatic Valves

The principle upon which these valves operate is perhaps most clearly shown in the section of the nonreturn boiler stop valve, Fig. 1. Upon a spider fixed

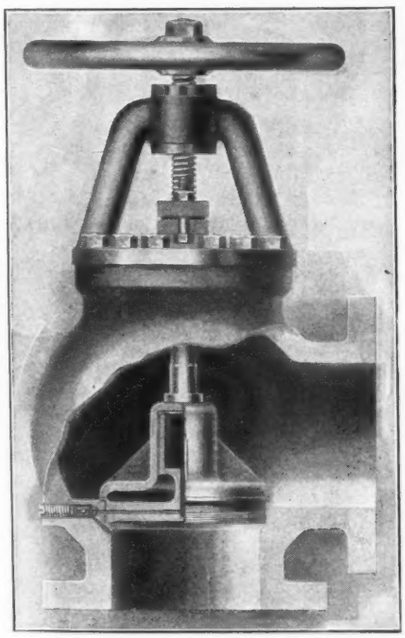


FIG. 1. BRADFORD AUTOMATIC NONRETURN BOILER STOP VALVE

in the valve passage is carried a hollow stationary piston. Upon this piston slides freely a cylinder carrying the valve. The space inside the piston is connected to the boiler side of the valve seat through the port shown, and a small screw valve, the chitted head of which is accessible from the outside of the valve body, is provided to control the passage. The valve is not attached to the valve stem, the flattened end of which simply bears upon the top of the cylinder upon the valve disk.

When the stem is withdrawn the full boiler pressure inside the piston causes the valve disk to follow the stem upward, opening the passage for the flow of steam upward through the valve and into the main. Should the flow be reversed, as in case of an accident to the boiler, the valve will be carried to its seat by the backward flow, but will be prevented from slamming by the cushioning action of the steam in the cylinder, which, escaping slowly through the controlled passage, allows the valve to settle quietly to its seat.

In Fig. 2 is shown a protector valve, used to shut off automatically the flow

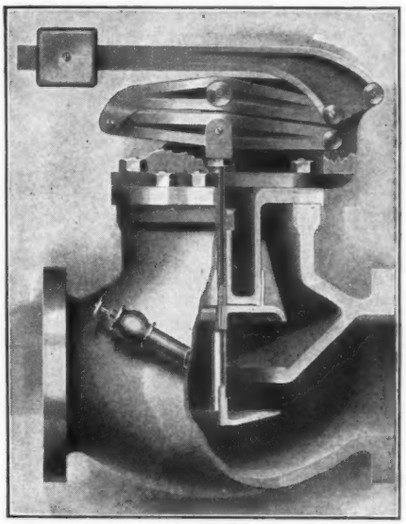


FIG. 2. BRADFORD PROTECTOR VALVE

of steam from a boiler or battery of boilers in case of a break in the main beyond. The valve is normally held open by the system of compound levers, but in case the velocity of the steam exceeds the normal by a predetermined amount, about 2000 feet per minute for the usual case, the force of its impingement upon the saucer-shaped attachment hung to the valve disk will carry that disk to its seat. The pressure upon the top of the disk will be reduced by the expansion of the steam in the cylinder, and the controlled entrance of steam to this chamber will allow the valve to seat quietly. The same principle is shown applied to a combined atmospheric-relief and back-pressure valve in Fig. 3. Here steam at the low pressure, or air in the case of an atmospheric relief, is admitted to the cylinder and by expansion holds the valve from slamming in the case of closing or by its compression in the case of sudden opening, and by its resistance to change of volume prevents chattering at any phase of the valve's operation.

In addition to the controlling feature the compensating chamber forms a central guide of ample area for the valve disk, even when used in a horizontal position. The chamber is bronze lined, and the seat is of government bronze and

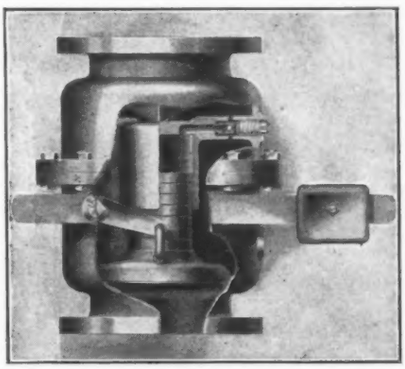


FIG. 3. COMBINED ATMOSPHERIC RELIEF AND BACK-PRESSURE VALVE

interchangeable. They are made by the Jno. B. Perkins Company, 141 Milk street, Boston, Mass.

Perolin Boiler Compound

This boiler compound has no chemical action on the water, but works its way through the cracks in the scale and along the metal of a boiler until the scale drops off and the boiler metal is coated with a film of the compound, to which, it is stated, no scale-forming sediment of any kind can cling.

The compound does not dissolve the scale, but only removes it from the iron so that it can be blown out through the blowoff or washed out when cleaning boilers. It also holds the scale-forming sediment in solution.

Water does not contain the same scale-forming sediment throughout the year, but continually changes with the season, climate and locality, but iron throughout the world is always the same. Therefore, there is a constant, known quantity with which to deal and the manufacturers have, it is said, developed a compound which is drawn to the heated iron and which mechanically removes the old scale and prevents the formation of new scale.

The compound is in the form of a thick liquid, and can be easily fed into the boiler either into the suction line or directly into the hotwell, and fed to the boiler by an injector or pump.

This compound is manufactured by the Eagle Oil and Supply Company, 104 Broad street, Boston, Mass.

Quite a few steam plants have gone out of business, but the central station is still working day and night.

Institute of Operating Engineers in Chicago

Since the first of the year there has been in process of formation a Chicago branch of the Institute of Operating Engineers. Monthly meetings have been held in the rooms of the Western Society of Engineers and the movement is now well under way. At the last meeting, which was held May 2, it was decided that there would be no further monthly meetings until the fall, when a vigorous campaign will be conducted and a systematic course of lectures arranged for, all having a bearing on the problems which the operating engineer must solve in his everyday work.

The Chicago organization will be known as the T. J. Waters branch. Mr. Waters was a prominent operating engineer of Chicago and was for many years chief engineer of the Board of Education. He made a special study of heating and ventilating problems and his work in this connection received honorable mention at the Paris Exposition.

Officers have been chosen as follows: P. J. Fleming, branch chairman; W. L. Jackson, lecturer on plant operation; I. J. Bent, lecturer on educational subjects; O. Monnett, secretary-treasurer. Address of the secretary, 1214 People's Gas building, Chicago.

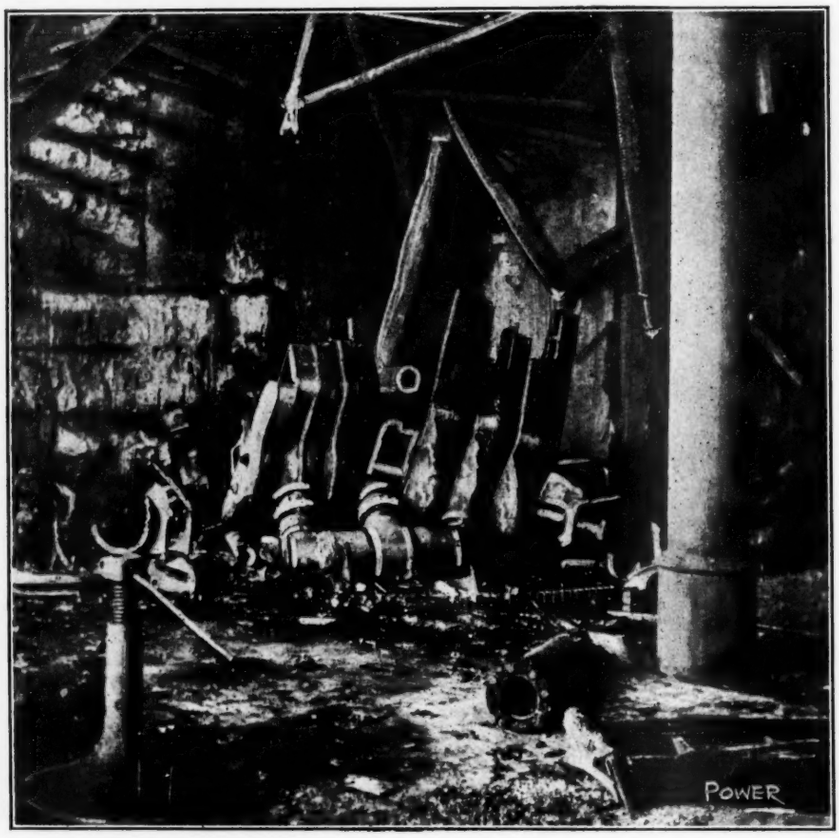
Heating Boiler Explosion Kills Two

Two men were killed and one injured, probably fatally, when a low-pressure sectional boiler exploded in the basement of the supply house of the Union Electric Light and Power Company, St. Louis, Mo., May 4, at about 9 o'clock at night.

The men had gone to the subcellar to get some wire and, according to the advices received, found that the boiler was highly overheated, due to lack of water. One of the men opened a valve in the water-supply pipe and when the cold water struck the cast-metal sections an explosion followed.

The low water was caused by some derangement of the return pipes of the heating system. The night watchman discovered that the water of the return tank of the system was overflowing, instead of returning to the boiler.

Details regarding the exact nature of the stoppage of water have not been obtainable at this writing.



REMAINS OF HEATING BOILER WHICH KILLED TWO MEN

The Electrical Engineers' Pacific Coast Meeting

The Pacific Coast meeting of the American Institute of Electrical Engineers was held at the Hotel Alexandria, Los Angeles, Cal., on April 25 to 29 inclusive. Seven business sessions were conducted at which the various papers arranged for by the committees were presented and discussed.

On Tuesday afternoon an excursion was made to Redondo beach, where the party inspected the power plant of the Pacific Light and Power Corporation. On Wednesday a trip was taken to Pasadena and up Mount Lowe over the spectacular trolley route. On Friday an all-day trip was made to the Mill Creek power plant of the Southern California Edison Company, about eight miles from Mentone in San Bernardino county. A purely pleasure trip was made on Saturday to Catalina Island, starting from Los Angeles at 9:50 a.m. About 300 members and guests were registered.

PERSONAL

George W. Stetson, New England agent for various manufacturers of power-plant equipment, is now located in the Oliver building, room 510, Boston, Mass.

Fred S. Hickey, formerly with the Anchor Packing Company, has associated himself with the Dearborn Drug and Chemical Works, as salesman for their feed-water treatment and lubricants, in the loop district of Chicago.

On the evening of May 3, Col. E. D. Meier, president of the American Society of Mechanical Engineers, addressed a joint dinner of the local members of that society and the Providence Association of Mechanical Engineers at the West Side Club. These two organizations have recently affiliated and Colonel Meier's address was based upon this action.

Prof. F. R. Hutton, who is now president of the Industrial Safety Association, also addressed the meeting, speaking on safety appliances.

W. M. White, formerly of the I. P. Morris Company, of Philadelphia, has become associated with the Allis-Chalmers Company as manager and chief engineer of the hydraulic-turbine department. During the past ten years, Mr. White has been closely in touch with hydraulic-turbine development in this country and for the past five years has had entire charge of the designing for the I. P. Morris Company, in which position he has designed the hydraulic machinery for some of the largest installations in the country. These include such notable plants as that of the Hydraulic Power Company and the Toronto Power Company, of Niagara Falls, the Great Western Power Company, of California, the Washington Power Company, of Spokane, Wash., and the Shawinigan Falls Power Company, of Montreal, Can. Mr. White also designed some of the large centrifugal pumps for the New Orleans drainage system and those that supply the water for the city of Duluth.

Moments with the Ad. Editor

A department for subscribers edited by the advertising service department of Power

As each weekly issue of POWER is only large enough to supply the regular subscribers and advertisers, it is necessary several times a year to print extra copies to help the mail order circulation department secure new subscriptions.

These extra copies are sent to engineers whose names have been obtained by our paid subscription men or have been sent in by employers or friends.

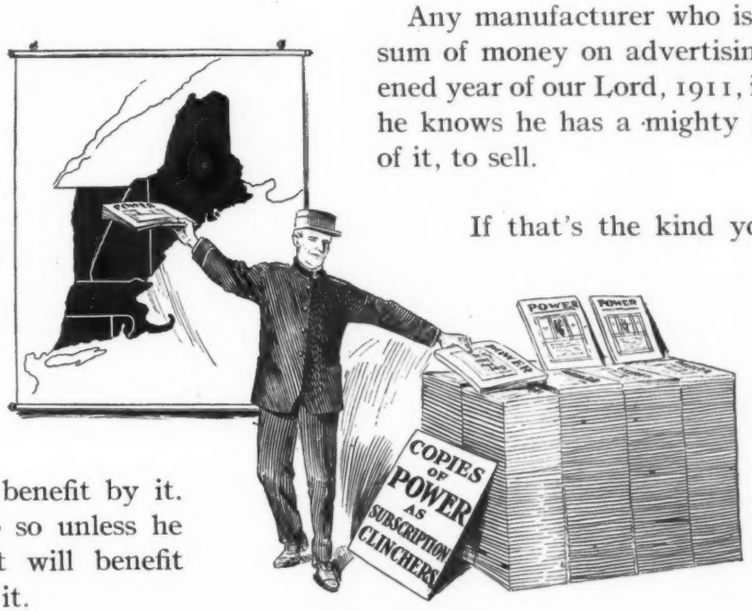
This issue is one of the extra-circulation numbers, all the extra copies of which will be circulated exclusively in New England.

To take advantage of this added circulation many of our advertisers have increased their space for this issue in order to tell the story of their product even more thoroughly and attractively than usual.

The result is, as you will see, one of the best, most-valuable-to-the-reader Selling Sections that POWER has ever printed.

And you'll find that the Rule of Advertisingworks here as elsewhere.

The advertiser buys space and prints his ad because he expects to benefit by it. He can't possibly do so unless he has a product that will benefit the reader who buys it.



Hence, when an advertiser takes extra space to tell a more complete story about his article—then is a good time for you to give extra time to the consideration of the advertisements.

Every page in the Selling Section of POWER contains interesting, valuable points for the engineer.

Practically every advertiser offers to send, free, booklets, catalogs and other printed matter to any reader.

The engineer who does not read and profit by the ads in such a number as this, is letting opportunities slip through his fingers—and that's the surest, quickest way on record to fall behind the procession.

The way men protect themselves nowadays is by reading the ads in their paper, by investigating the advertiser's products, and by buying advertised goods only.

Any manufacturer who is spending a large sum of money on advertising in this enlightened year of our Lord, 1911, is doing it because he knows he has a mighty good article back of it, to sell.

If that's the kind you want to buy, read the ads and act on them.

You can't find a better number to begin on than this one of May 16.

BUSINESS ITEMS

The Vilter Manufacturing Company, Milwaukee, Wis., builders of Corliss engines, ice and refrigeration machinery, report 28 recent sales, including 16 Corliss engines and refrigeration machines, with a total of 605 tons capacity.

Walter B. Snow, publicity engineer, 170 Summer street, Boston, Mass., has recently added to his staff, John S. Nicholl, late of the New York Edison Company, and formerly acting manager for F. W. Horne, importer of American machinery, Yokohama, Japan.

F. S. Broadhurst, formerly in the employ of the C. H. Wheeler Manufacturing Company, of Philadelphia, and recently with the Westinghouse Machine Company, has rejoined the C. H. Wheeler Manufacturing Company, assuming the position of sales manager, with his headquarters at Philadelphia.

Wolcott Remington, well known as a designer and manufacturer of oil engines, has associated himself with the Blanchard Machine Company, Cambridge, Mass. He is now engaged in getting out for them a line of stationary and marine oil engines ranging from 10 to 100 horsepower, which will be manufactured under the name of the Blanchard oil engine.

The American Ship Windlass Company, manufacturer of the Taylor stoker, has just received an order from the Milwaukee Electric Railway and Light Company, for four stokers to be applied to four 800-horsepower Edge Moor boilers. These stokers are to be used in the Commerce Street plant. This company has for a considerable period carried on an exhaustive series of experiments with stokers before placing this order.

A well-illustrated 48-page booklet has been prepared by Frank L. Patterson & Co., which should be of interest to engineers and power-plant men in general. The title is "Guaranteed Coal Saving." One chapter gives a comparison between open and closed types of feed-water heaters. Any engineer or steam user seeking economical boiler results can get a copy of this booklet by writing to Frank L. Patterson & Co., 28 Cortlandt street, New York.

Owing to confusion between various "Simplex" companies, the Simplex Engineering Company, 1111 Locust street, Philadelphia, Penn., has changed its name to the Yarnall-Waring Company. No change in the standing, management or ownership of the business will be made. In addition to the manufacture of the Simplex seatless blow-off valve and the Simplex pipe-joint clamp, it has added the Caskey line of hydraulic and pneumatic valves and couplings, also the Lea water-flow recorder.

NEW EQUIPMENT

Freeport, Me., will build a new water plant.

Meriden, Conn., will improve its water system.

Colquitt, Ga., will erect a $75,000 electric-light plant.

Mount Vernon, N. Y., will have a new water system.

Hood River, Ore., will install a waterworks system to cost $90,000.

Rochester, N. H., will build a new municipal electric-light plant.

Canterbury Brothers, Higginsville, Mo., will erect a 10-ton ice plant.

The Weinhard Brewery, Portland, Ore., will improve its power plant.

H. J. Perkins, Springfield, Mass., will erect a new cold-storage building.

The Amherst (Mass.) Gas Company will make improvements in its plant.

Webster, Mass., contemplates installing a municipal electric-lighting plant.

W. H. Grover, of Ames, Iowa, will erect an electric plant at Jewell, Iowa.

Caldwell, Idaho, is planning the installation of an electric-lighting system.

The Faith (S. D.) Light and Power Company has been granted franchise.

W. H. Anderson, Ogden, Utah, will erect a cold-storage plant at Kearney, Neb.

Rockland, Mass., contemplates the erection of a municipal light and power plant.

The Anderson & Middleton Mill, Aberdeen, Wash., will install an electric power plant.

Fred J. Cross, Monticello, Iowa, will erect a plant to supply power to several towns.

Middlebury College, Middlebury, Vt., will make additions to its power and heating plant.

J. O. Baumgarten, of Camden, N. J., will build a large brewery plant at Bakersfield, Cal.

The Samaritan Hospital, Philadelphia, Penn., will install a new heating and lighting plant.

Hobson Brothers Packing Company, Ventura, Cal., will install a new refrigerating plant.

J. A. Johnson, of Keosauqua, Iowa, has been granted franchise to install an electric plant.

The Salem (Ore.) Woolen Mills will make improvements and additions in its power plant.

The Franklin Brewing Company, Columbus, Ohio, will build a large addition to its engine room.

Fred Pfund is building a cold-storage plant at 3949 Germantown avenue, Philadelphia, Penn.

Fire destroyed the plant of the Lancaster (Ky.) Electric Light Company. Will be rebuilt.

Everly & Collins, Castlerock, Wash., are planning to build a power plant on the Turtle river.

The Southern Power Company, Durham, N. C., has purchased site for a distributing station.

The Coalinga Mohawk Oil Company, Coalinga, Cal., will build a new boiler plant. Four units will be installed.

A. F. Shepard, superintendent, Dayton State Hospital, Dayton, Ohio, will receive bids May 23, for furnishing and installing a complete 250-kilowatt direct-current generator.

HELP WANTED

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

WANTED—Experienced foreman engineer for sugar refinery; credentials required. Apply P. O. Box 1660, Vancouver, B. C.

ENGINEERS WANTED to solicit for the Rolin patent adjustable grate. Apply Standard Grate Co., Heed Bldg., Philadelphia.

WANTED—Thoroughly competent steam specialty salesman; one that can sell high-grade goods. Address "M. M. Co.," POWER.

AN ENGINEER in each town to sell the best rocking grate for steam boilers. Write Martin Grate Co., 281 Dearborn Street, Chicago.

AGENTS WANTED for first-class steam specialty in use throughout United States. Address C. S. Wood, 410 S. 15th St., Philadelphia, Penn.

SALESMAN calling at power plants to handle as a side line superior packing for steam, different from the rest and better. Nugget Packing Co., 185 Summer St., Boston, Mass.

WANTED—An engineer in each city as agent for a high class water-back Scotch boiler, the most economical steam generator known to the trade. Kingsford Foundry & Machine Works, Oswego, N. Y.

POSITION OPEN—Water wheel chief engineer; thoroughly competent designer and constructor to take full charge of latest up to date Francis turbine wheels and governors; applicant must have extended experience; give full particulars. Box 441, POWER.

WANTED—A first class representative in Pittsburg to handle a reliable high speed engine account on commission basis; prefer a representative who is at present, and will continue, handling power plant equipment that does not compete with the high speed type engine. Box 421, POWER.

WANTED—Engineer to take charge of 50 kilowatt producer gas plant for electric lighting; applicant must be familiar with Westinghouse gas engines and producers; state age, experience and salary desired; climate very good; living expenses about six dollars a week. Address Arsuaga & Co., Ltd., Box 41, Manati, Porto Rico.

SALESMAN to represent large manufacturer of refrigerating and ice making machinery; must be experienced in handling propositions involving large amounts; should have technical education or practical experience; position in good territory with fine opportunity for doing much business. In applying, state age, experience and salary expected. Address Box 439, POWER.

SITUATIONS WANTED

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

POSITION WANTED—Superintendent of electric light and power plant or municipal light and water works; fifteen years' experience; first class references; will go anywhere. Address Box X75, POWER, 1214 People's Gas Bldg., Chicago.

TECHNICAL MAN, 34, married, 13 years' experience, power, light, telephone, construction and operation, want connection as electrical engineer or superintendent, light or power plant; good business ability; prefer West or South; would consider foreign country. Box 433, POWER.

GAS ENGINEER to take charge of producer gas engine plants, familiar with the erecting and operating of large horizontal and vertical gas engines; suction and pressure producers; low and high grade fuel; indicating and fuel analyses; mechanic and machinist; now in charge of 2000 horsepower plant in Mexico; age 37; willing to go to any place. Box 440, POWER.

MISCELLANEOUS

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

PATENTS. C. L. Parker, Patent Attorney, ex-examiner Patent Office, 904 G St., Washington, D. C. Write for Inventor's Handbook.

The Vulcan Soot Cleaner offers an exceptional opportunity for power specialty salesmen. For further particulars address G. L. Simonds & Co., 802 Steinway Bldg., Chicago, Ill.

SUBSCRIBE NOW for the 1911 issue of the Stationary Engineers' Directory of the city of Philadelphia; $5 per copy. Mail checks to Stationary Engineers' Club, 1108 Arch street, Philadelphia, Penn.

EVERY ENGINEER should be posted regarding the new system of vacuum heating installed without payment of royalty; I have valuable information; write today. T. L. Reeder, 1417 W. Jackson Blvd., Chicago, Ill.

BIDS WILL BE RECEIVED by the city clerk of Sioux City, Iowa, until 10 a.m., May 20, 1911, for furnishing and installing two triplex pumps and two gasolene engines; specifications may be had at the office of G. B. Healy, Supt. Parks and Public Property.

FOR SALE

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

ONE IDE HIGH SPEED automatic engine, 10x14 inches; shaft governor, heavy flywheel, out board bearing. Box 435, POWER.

FOR SALE—20x48 Wheelock engine and two 72"x18' high pressure tubular boilers in good condition cheap. Address "Engineer," Box 2, Station A, Cincinnati, Ohio.

FOR SALE—50 horsepower horizontal tube Bigelow boiler, 35 horsepower Greenfield vertical engine, both in good condition; will sell together or separately. General Acoustic Company, Jamaica, N. Y.

FOR SALE—One compound Reynolds Corliss engine, high pressure cylinder 32 inches, low pressure 60 inches, stroke 60, 1200 horsepower at 100 pounds pressure, 70 revolutions per minute, flywheel diameter 20 feet, face 56 inches, built in sections; shaft length 16 feet diameter in wheel 16 inches, single eccentric. Box 434, POWER.

ALMOST NEW 10"x20" mill frame Watertown right hand engines, cost $950 three years ago, will sell for $300; also 14"x26"x 16" Harrisburg compound ideal engine guaranteed, only $800; two 175-horsepower vertical butt jointed Manning boilers, 135 pounds pressure; no brick work except foundation required. $500 each. J. F. Foster, 166 Devonshire St., Boston, Mass.

ALPHABETICAL INDEX TO ADVERTISERS

PAGE

Advance Packing & Supply Co. 86
Air-Flex Co. 148
Albany Lubricating Co. 104, 105
Alberger Condenser Co. 88
Allis-Chalmers Co. 89
American District Steam Co. 100
American Eng. Co. 157
American Goetze-Gasket and Packing Co. 95
American Injector Co. 126
American Mfg. Co. 4th cover
American Metal Hose Co. 156
American Ship Windlass Co. 125
American Steam Gauge and Valve Mfg. Co. 70 and 71
Ames Iron Works. 157
Anderson Co., V. D. 83
Armstrong Mfg. Co. 126
Ashton Valve Co. 130
Ault & Wiborg Co. 84
Austin Separator Co. 82

Babcock & Wilcox Co. 138
Baker Valve Co. 156
Ball & Wood Co. 158
Ball Engine Co. 158
Baragwanath & Son, Wm. 108
Barnes Co., W. F. & John 138
Bates Machine Co. 108
Bayer Steam Soot Blower Co. 151
Beggs, James. 137
Betson Plastic Fire Brick Co. 144
Bignall & Keeler Mfg. Co. 126
Blake & Knowles Steam Pump Works 110
Bogart Gas Power Engineering Co. 152
Borden Co., The. 126
Bristol Co. 4th cover
Bruce-Macbeth Engine Co. 102
Buckeye Boiler Skimmer Co. 148
Buckeye Engine Co. 159
Buffalo Forge Co. 158
Builders Iron Foundry. 97
Burt Mfg. Co. 18

Cade & Knapp. 84
Cameron Steam Pump Works, A. S. 89
Cancos Mfg. Co. 94
Casey-Hedges Co. 138
Chaplin-Fulton Co. 140
Chapman Valve Mfg. Co. 132
Chesterton Co., A. W. 136
Cincinnati Gasket & Packing Co. 94
Cling-Surface Co. 115
Columbian Rope Co. 118
Cooper Co., C. & G. 154
Corliss Chemical Co. 144
Crocker-Wheeler Co. 93
Crosby Steam Gage & Valve Co. 133
Curtis & Curtis Co. 131
Cyclone Grate Bar Co. 119

Danubil Company, The. 96
Dart Mfg. Co., E. M. 133
De Laval Steam Turbine Co. 153
Deane Steam Pump Co., The. 86

PAGE

Dearborn Drug & Chemical Works 5
Deming Co. 88
Detroit Lubricator Co. 102
Diamond Power Specialty Co. 117
Diamond Rubber Co. 94
Direct Separator Co. 83
Dixon Crucible Co., Jos. 105
Du Bois Iron Works. 154

Elliott Co., 7, 83, 84, 97, 105, 108 and 134
Elyria Gas Power Co. 155
Epping-Carpenter Co. 89
Eureka Packing Co. 78

Fitchburg Steam Engine Co. 159
Flexible Steel Lacing Co. 118
Flower Co., Walter L. 105
Foos Gas Engine Co. 154
Foster Engineering Co. 128
Franklin Boiler Works Co. 141

Garlock Packing Co. 9
General Electric Co. 2
Golden-Anderson Valve Spec. Co. 132
Green Engineering Co. 120
Greene, Tweed & Co., 101 and 4th cover
Griffith & Wedge Co. 158
Griscom-Spencer Co. 111

Hammel Oil Burner Co. 123
Harbison-Walker Refractories Co. 147
Harris Steam Engine Co., W. A. 156
Harrisburg Fdry. and Mach. Works 158
Harrison Safety Boiler Wks. 73
Havard Co., O. D. 123
Hawkes Boiler Co. 143
Heine Safety Boiler Co. 141
Hewes & Phillips Iron Wks. 157
Hoffman, Geo. W. 156
Homestead Valve Mfg. Co. 132
Hooven, Owens, Rentschler Co. 159
Hoppes Mfg. Co. 110
Hughson Steam Specialty Co. 134
Huyette Co., Inc., Paul B. 124

Ingersoll-Rand Co. 100
International Corr. Schools 77
International Harvester Co. of America 154

Jamieson & Co., M. W. 88
Jefferson Union Co. 10
Jeffrey Mfg. Co., The. 123
Jenkins Bros. 75
Jerguson Mfg. Co. 141
Johns-Manville Co., H. W. 97
Johnson Rule Mfg. Co. 123

Keeler Co., E. 140
Kennicott Co. 93
Keystone Lubricating Co. 3
Kingsford Fdry. & Mach. Wks. 140
Kinkead Mfg. Co. 118

Lagonda Mfg. Co. 3d cover
Leavitt Machine Co. 127

PAGE

Liberty Mfg. Co. 7
Lisk, J. P. 97
Long Grate Bar Co. 120
Lunkenheimer Co. 4

McClave-Brooks Co. 14
McGraw-Hill Book Co. 98
McIntosh, Seymour & Co. 157
McLeod & Henry Co. 146
Magnolia Metal Co. 152
Manzel Bros. Co. 102
Martin Grate Co. 121
Mason Regulator Co. 132
Minneapolis Steel & Mach. Co. 152
Monarch Valve & Mfg. Co. 134
Morehead Mfg. Co. 82
Morrin Climax Boiler Co. 138
Morse Chain Co. 162
Murphy Iron Works. 123
Murray Automatic Boiler Feed Co. 144

Nashua Machine Co. 83
National Pipe Bending Co. 111
National Tube Co. 126
Neemes Bros. 121
Nelson Valve Co. 135
New Bedford Valve Mfg. Co. 129
New England Raw Hide Co. 138
New York & New Jersey Lubricant Co. 99
New York Belting & Packing Co., Ltd. 12
New York Edison Co. 80
Newhall Engr. Co., Geo. M. 85
Northern Equipment Co. 93

Ohio Blower Co. 113
Ohio Brass Co. 128
Ohio Injector Co. 130
Oil City Boiler Works. 141
Oil Well Supply Co. 138
Open Coil Heater & Purifier Co. 108
Osgood Mfg. Co. 144

Parker Boiler Co. 93
Parson Mfg. Co. 121
Patterson & Co., Frank L. 106 and 107
Peerless Rubber Mfg. Co. 8
Penberthy Injector Co. 13
Pennsylvania Coal & Coke Co. 122
Pennsylvania Flexible Metallic Tubing Co. 84
Perfection Grate Co. 119
Perkins Co., J. B. 129
Philadelphia Grease Mfg. Co. 103
Pierce Co., Wm. B. 2d cover
Pittsburgh Valve, Fdry. and Construction Co. 132
Power Specialty Co. 89
Precision Instrument Co. 145
Providence Engineering Wks. 158

Reliance Gauge Column Co. 140
Remington Oil Engine Co. 156
Rhoads & Sons, J. E. 114
Richardson-Phenix Co. 100
Ridgway Dynamo and Engine Co. 157

PAGE

Robb Engineering Co., Ltd. 142
Robertson & Sons, Jas. L. 79
Rogers & Co., H. A. 84
Rollins Engine Co. 160 and 161
Rooksby & Co., E. J. 156
Royersford Fdry. & Mach. Co. 117
Ruggles Co., Walter G. 92

S-C Regulator Co., The. 80
Saginaw Mfg. Co. 118
St. John, G. C. 138
Salamander Grate Bar Co. 121
Scaife & Sons Co., Wm. B. 134
Schieren Co., Chas. A. 1st cover
Schuchardt & Schutte. 136
Schutte & Koerting Co. 133
Simonds & Co., G. 148
Skinner Engine Co. 158
Smooth-On Mfg. Co. 9
Squires Co., C. E. 84
Standard Grate Co. 120
Star Brass Mfg. Co. 90 and 91
Starrett Co., L. S. 120
Steam Appliance Co., The. 83
Struthers-Wells Co. 154
Sturtevant Co., B. F. 139
Superior Iron Works Co. 123

Thermoid Rubber Co. 11
Thomas Threading Machine Co. 128
Treadwell Co., M. 120
Trill Indicator Co. 81
Trimont Mfg. Co. 118 and 150
Turbo-Blower Co. 123
Turner-Fricke Mfg. Co. 152

Uehling Instrument Co. 144
Under-Feed Stoker Company of America 124
Underwood & Co., H. B. 158
Union Steam Pump Co. 89
Universal Lubricator Co. 15

Vilter Mfg. Co. 159
Vogt Machine Co., Henry 138
Von Kokeritz & Co., R. G., 94 and 102
Vulcan Furnace Co., The. 122
Vulcan Soot Cleaner Co. 149

Walton Co., F. S. 16 and 17
Washburn & Granger. 121
Watson & McDaniel Co. 88
Watts-Campbell Co. 157
Westinghouse Elec. & Mfg. Co. 162
Wheeler Mfg. Co., C. H. 87
Whitlock Coil Pipe Co. 128
Wickes Boiler Co. 140
Willcox Engineering Co. 148
Williams & Co., J. H. 124
Williams Fdry. & Mach. Co. 118
Williams Tool Co. 109
Wing Mfg. Co., L. J. 124
Wright Mfg. Co. 82
Wyckoff & Son Co., A. 133

Yale & Towne Mfg. Co. 126
Yarnall-Waring Co. 134

Ziermore Regulator Co. 126

CLASSIFIED INDEX TO ARTICLES ADVERTISED

Air Compressors

Allis-Chalmers Co. 89
Bates Machine Co. 108
Ingersoll-Rand Co. 100
Perkins Co., Jno. B. 129
Union Steam Pump Co. 89

Alarms, Low Water

Elliott Co., 7, 83, 84, 97, 105, 108 and 134
Lunkenheimer Co. 4
Reliance Gauge Column Co. 140
Wright Mfg. Co. 82

Alternators

Allis-Chalmers Co. 89
General Electric Co. 112

Asbestos Goods and Materials

Johns-Manville Co., H. W. 97

Belt Dressing

Cling-Surface Co. 115
Garlock Packing Co. 9
Keystone Lubricating Co. 3
Rhoads & Sons, J. E. 114
Schieren Co., Chas. A. 1st cover
Smooth-On Mfg. Co. 6
Walton Co., F. S. 16 and 17

Belt Lacing

Bristol Co. 4th cover
Flexible Steel Lacing Co. 118
Schieren Co., Chas. A. 1st cover

Belting

Diamond Rubber Co. 94
Garlock Packing Co. 9
Jeffrey Mfg. Co. 123
New York Belting & Pack. Co. 12
Peerless Rubber Mfg. Co. 8
Rhoads & Son, J. E. 114
Schieren Co., Chas. A. 1st cover

Belting, Chain

Morse Chain Co. 162

Blocks, Chain

Yale & Towne Mfg. Co. 126

Blowers, Fan

Beggs & Co. 137
Ohio Blower Co. 113
Sturtevant Co., B. F. 139
Turbo-Blower Co. 123
Wing Mfg. Co., L. J. 124

Blowers, Steam Jet

Beggs & Co. 137
McClave-Brooks Co. 14
Parson Mfg. Co. 121
Schutte & Koerting Co. 133

Boiler Compound

Corliss Chemical Co. 144
Dearborn Drug and Chemical Works 5

Boiler Compound—*Continued.*

Elliott Co., 7, 83, 84, 97, 105, 108 and 134
Johns-Manville Co., H. W. 97
Keystone Lubricating Co. 3
Osgood Mfg. Co. 144

Boiler Fronts

Casey-Hedges Co. 138

Boiler Setting

Air-Flex Co. 148
Betson Plastic Fire Brick Co. 144
Harbison-Walker Refractories Co. 147
McLeod & Henry Co. 146

Boiler Tube Cap Reseating Machines

Elliott Co., 7, 83, 84, 97, 105, 108 and 134
Lagonda Mfg. Co. 3d cover
Leavitt Machine Co. 127
Liberty Mfg. Co. 7

You can quickly tell whether the steam gauges are wrong or not

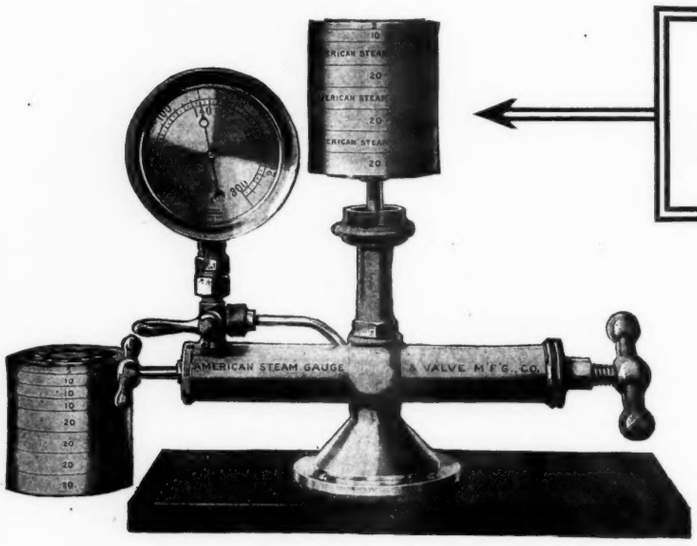
By testing them with an American Dead Weight Gauge Tester.

The illustration shows you how simple this device is—nothing to study before you can use it—nothing to get out of order—as simple as any weighing scales.

Attach the gauge—put on the dead weights and watch the figures. A glance shows whether the gauge is registering correctly or how far it is wrong.

It's a simple device that guards against loss of coal due to gauge inaccuracy. Let us send you full details of the

American Dead Weight Gauge Tester



Full Details on Request

American Steam Gauge & Valve Mfg. Co.

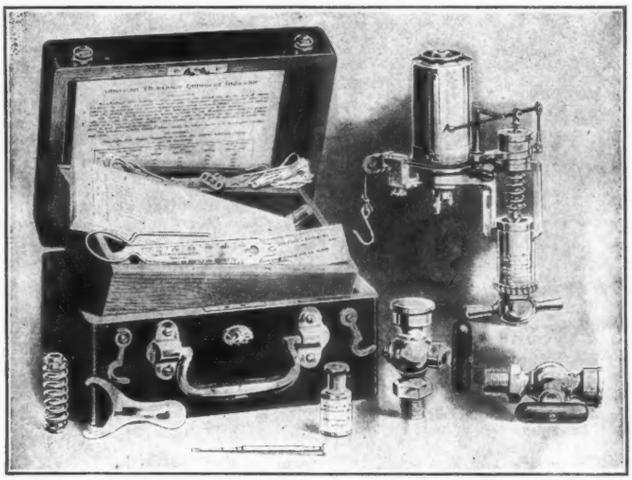
Boston, Mass.

New York, 29 Cortlandt St.
Pittsburg, Columbia Bank Bldg.

Atlanta, 525 Candler Bldg.
San Francisco, Monadnock Bldg.
Los Angeles, 213 So. Los Angeles St.

Chicago, 130-132 Jefferson St.
Montreal, 444 St. James St.

$5.00 Down



$5.00 Monthly

The Best Indicator on Easy Terms
American-Thompson Indicator

(The only original J. W. Thompson Improved Indicator—All others are imitations)

When you buy your American-Thompson Improved Indicator you *know* that you are buying an Indicator that will give you as accurate service after years of use as when new.

Thousands of them are in use in all parts of the world—every one has been sold on a "money-back-if-not-satisfied" basis—not one has been returned. **The following letters show you what users think about them:**

Some Details

Made complete in one factory.

Special metals are used; experienced, high priced men do the assembling.

Improved detent motion is patented and can only be used on the American-Thompson.

It is unvaryingly *accurate*.

Each instrument is put to a test, more severe than any you will ever give it.

Derby, Mar. 24, 1911

Dear Sirs—Enclosed you will find P.O. order for Five Dollars ($5.00), my monthly installment on indicator.

Speaking of the indicator I would like to say that as regards accuracy and simplicity it is the best instrument I have ever used and will take a pleasure in recommending it to any enquirer who intends buying one. Yours sincerely,

ADAM McMILLAN,
58 Elizabeth St., Derby, Conn.

Phila., Mar. 16, 1911

Gentlemen—I am pleased to acknowledge receipt of your Indicator outfit, and can only say "Dee-lighted."

Thanking you for your courtesy and prompt delivery, and assuring you I will remember the American Steam Gauge Co. in the future, I am,

Yours truly,
CHAS. A. WALDNER,
2851 N. 9th St.,
Phila., Pa.

If *you* had an American-Thompson Indicator you would be *thoroughly* familiar with your engine. You would know what's going on inside the cylinder as well as outside.

You would be able *to prove* that steam was being used wastelessly, that the valves were tight, and properly adjusted, that minimum drop in steam pressure existed between boiler and engine. *You could make yourself a better engineer; you could command more salary.*

The price of the American-Thompson Indicator as shown is $55.00 and the terms, ($5.00 down, $5.00 monthly,) put it easily within your means.

Send your first payment today with references and we'll ship your instrument at once, with privilege of examining it for a period of five days.

Don't put this important matter off any longer—act today. *Mail the coupon.*

American Steam Gauge & Valve Mfg. Company

Boston, Mass.

New York	Chicago	Atlanta
Pittsburg	San Francisco	Los Angeles

American Steam Gauge & Valve Mfg. Co.
Boston, Mass.

Send me full details of your Indicator Offer No. 110.

Name . . . . . .

Address . . . . . .

City and State . . . . . .

Boiler Tubes
National Tube Co.....126

Boiler Water Skimmers
Buckeye Boiler Skimmer Co..148

Boilers
Allis-Chalmers Co..... 89
Ames Iron Works.....157
Babcock & Wilcox Co.....138
Beggs & Co.....137
Casey-Hedges Co.....138
Franklin Boiler Works.....141
Griscom-Spencer Co. 111
Harrisburg Foundry & Mach. Works 158
Harrison Safety Boiler Wks.. 73
Hawkes Boiler Co.....143
Heine Safety Boiler Co.....141
Hewes & Phillips Iron Wks...157
Keeler Co., E.....140
Kennicott Co., The..... 93
Kingsford Fdry. & Mach. Co..140
Minneapolis Steel & Mchy. Co.152
Morrin Climax Boiler Co.....138
New Bedford Valve Mfg. Co..132
Oil City Boiler Works.....141
Oil Well Supply Co.....138
Parker Boiler Co..... 93
Perkins Co., Jno. B.....129
Robb Engineering Co., Ltd...142
Struthers-Wells Co.....154
Vogt Machine Co., Henry....138
Wickes Boiler Co.....140

Books
International Corr. Schools... 77
McGraw-Hill Book Co..... 98

Brick, Fire
Air-Flex Co.....148
Betson Plastic Fire Brick Co.144
Harbison-Walker Refractories Co. 147
McLeod & Henry Co.....146

Castings, Brass and Iron
Bruce-Macbeth Eng. Co.....102
Builders Iron Foundry..... 97
Hooven, Owens, Rentschler Co.159
Lunkenheimer Co..... 4
McClave-Brooks Co..... 14
Neemes Bros.....121
Salamander Grate Bar Co....121
Treadwell Co., M. H.....120

Castings, Steel
Hooven, Owens, Rentschler Co.159

Cement, Heat Resisting
Air-Flex Co. 148
Harbison-Walker Refractories Co. 147

Cement, Iron
Johns-Manville Co., H. W.... 97
Smooth-On Mfg. Co..... 6

Cement, Rubber
Peerless Rubber Mfg. Co..... 8

Chain Drives
Morse Chain Co.....162

Chimneys, Steel
Keeler Co., E.....140
Morrin Climax Boiler Co.....138

Clocks
American Steam Gauge and Valve Mfg. Co.....70 and 71

Clutches, Friction
Williams Fdry. & Mach. Co..118

Coal
Pennsylvania Coal & Coke Co.122

Coal and Ash Handling Machinery
Green Engineering Co.....120
Jeffrey Mfg. Co.....123
Parson Mfg. Co.....121

Cocks, Blow-off
Elliott Co., 7, 83, 84, 97, 105, 108 and 134

Cocks, Gage
American Steam Gauge and Valve Mfg. Co.....70 and 71
Chaplin-Fulton Mfg. Co.....140
Huyette Co., Paul B.....124
Jenkins Bros..... 75
Lunkenheimer Co..... 4
Ohio Blower Co.....113
Ohio Brass Co.....128
Reliance Gauge Column Co...140
S-C Regulator Co..... 80
Wright Mfg. Co..... 82

Cocks, Steam
Dart Mfg. Co., E. M.....133
Lunkenheimer Co..... 4
National Tube Co.....126
Schutte & Koerting Co.....133
Star Brass Mfg. Co...90 and 91

Combustion Chamber, Back Arch
Air-Flex Co.....148
Betson Plastic Fire Brick Co.144
Harbison-Walker Refractories Co. 147
McLeod & Henry Co.....146

Combustion Recorders
Precision Instrument Co.....145
Uehling Instrument Co.....144

Compound, Commutator
Dixon Crucible Co., Jos.....105

Condensers
Alberger Condenser Co..... 88
Allis-Chalmers Co..... 89
Anderson Co., V. D..... 83
Baragwanath & Son, Wm....108
Cameron Steam Pump Works, A. S..... 89
Deane Steam Pump Co..... 86
Epping-Carpenter Co..... 89
Griscom-Spencer Co.....111
Minneapolis Steel & Mchy. Co.152
Schutte & Koerting Co..88 and 133
Union Steam Pump Co..... 89
Wheeler Mfg. Co., C. H..... 87

Controllers, Electric
General Electric Co.....112

Controllers, Feed Water
Chaplin-Fulton Mfg. Co.....140
Elliott Co., 7, 83, 84, 97, 105, 108 and 134
Lagonda Mfg. Co.....3d cover
Liberty Mfg. Co..... 7
Mason Regulator Co.....132
Northern Equipment Co..... 93
Squires Co., C. E..... 84
Ziermore Regulator Co.....126

Conveying Machinery
Jeffrey Mfg. Co.....123

Cooling Plants
Schutte & Koerting Co.....133

Cooling Towers
Wheeler Mfg. Co., C. H..... 87

Cordage
American Mfg. Co.....4th cover
Columbian Rope Co.....118

Correspondence Schools
International Corr. Schools... 77

Couplings, Flexible Shaft
Bruce-Macbeth Engine Co.... 102
Hooven, Owens, Rentschler Co.159

Covering, Pipe and Boiler
Johns-Manville Co., H. W.... 97
Wyckoff & Son Co., A.....133

Cranes
Yale & Towne Mfg. Co.....126

Crank Pin Oiler
Richardson-Phenix Co. 100

Curbs, Manhole
Armstrong Mfg. Co.....126

Cylinder Boring Bars
Underwood & Co., H. B.....158

Die Stocks
Armstrong Mfg. Co.....126
Bignall & Keeler Mfg. Co....126
Borden Co. 126
Curtis & Curtis Co.....131
Toledo Pipe Threading Mach. Co. 128

Draft, Mechanical
Parson Mfg. Co.....121
Schutte & Koerting Co.....133
Sturtevant Co., B. F.....139
Turbo-Blower Co.....123
Wing Mfg. Co., L. J.....124

Drills, Upright
Barnes Co., W. F. & John....138

Dust Collectors
Ohio Blower Co.....113
Sturtevant Co., B. F.....139

Dynamos
Allis-Chalmers Co..... 89
American Engine Co.....157
Bruce-Macbeth Eng. Co.....102
Crocker-Wheeler Co..... 93
General Electric Co.....112
Ridgway Dynamo and Engine Co. 157

Economizers, Fuel
Parson Mfg. Co.....121
Sturtevant Co., B. F.....139
Westinghouse Machine Co....162

Ejectors
American Injector Co.....126
Beggs & Co. 137
Lunkenheimer Co..... 4
Ohio Injector Co.....130
Penberthy Injector Co..... 13
Schutte & Koerting Co.....133

Electric Current
New York Edison Co..... 80

Engine Repairs
Rooksby & Co., E. J.....156
Underwood, H. B.....158

Engine Stops
Schutte & Koerting Co.....133

Engines, Combustion
Allis-Chalmers Co..... 89
Beggs & Co. 137
Bogart Gas Power Engineering Co. 152
Bruce-Macbeth Eng. Co.....102
Buckeye Engine Co.....148
Du Bois Iron Works.....154
Elyria Gas Power Co.....155
Foos Gas Engine Co.....154
International Harvester Co. of America 154
Minneapolis Steel & Mchy. Co.152
Struthers-Wells Co.....154
Turner-Fricke Mfg. Co.....152
Westinghouse Machine Co....162

Engines, Oil
Foos Gas Engine Co.....154
Remington Oil Engine Co....156

Engines, Pumping
Hooven, Owens, Rentschler Co.159

Engines, Steam
Allis-Chalmers Co..... 89
American Engine Co.....157
Ames Iron Works.....157
Ball & Wood Co.....158
Ball Engine Co.....158
Bates Machine Co.....108
Beggs & Co. 137
Buckeye Engine Co.....159
Buffalo Forge Co.....158
Cooper Co., C. & G.....154
Du Bois Iron Works.....154
Fitchburg Steam Engine Co..159
Griffith & Wedge Co.....158
Griscom-Spencer Co.....111
Harris Steam Engine Co.....156
Harrisburg Fdry. & Mach. Wks.158
Hewes & Phillips Iron Wks..157
Hooven, Owens, Rentschler Co.159
McIntosh, Seymour & Co....157
Minneapolis Steel and Machinery Co. 152
Perkins Co., Jno. B.....129
Providence Engr. Works.....158
Ridgway Dynamo & Engine Co.157
Rollins Engine Co...160 and 161
Skinner Engine Co.....158
Sturtevant Co., B. F.....139
Vilter Mfg. Co.....159
Watts-Campbell Co.....157
Westinghouse Machine Co....162

Exhaust Heads
Burt Mfg. Co..... 18
Elliott Co., 7, 83, 84, 97, 105, 108 and 134
Hoppes Mfg. Co.....110
Ohio Blower Co.....113
Patterson & Co., Frank L., 106 and 107
Robertson & Sons, Jas. L.... 79
Ruggles Co. 92
Sturtevant Co., B. F.....139
Whitlock Coil Pipe Co.....140
Wright Mfg. Co..... 82

Expansion Joints
Alberger Condenser Co..... 88
National Tube Co.....126

Fans, Electric
General Electric Co.....112
Westinghouse Elec. & Mfg. Co.162

Fans, Exhaust and Ventilating
Anderson Co., V. D..... 83
Buffalo Forge Co.....158
General Electric Co.....112
Power Specialty Co..... 89
Turbo-Blower Co.....123
Wing Mfg. Co., L. J.....124

Feed Water, Weighers
Kennicott Co., The..... 93
Wilcox Engineering Co.....148

Feeders, Boiler Compound
Richardson-Phenix Co. 100

Feeders, Furnace
Ohio Blower Co.....113

Filters, Oil
Burt Mfg. Co..... 18
Elliott Co., 7, 83, 84, 97, 105, 108 and 134

Filters, Oil—*Continued.*
Flower Co., W. L.....105
Richardson-Phenix Co. 100
Robertson & Sons, Jas. L..... 79
Ruggles Co., Walter G..... 92
Wright Mfg. Co..... 82

Filters, Water
Griscom-Spencer Co.....111
Scaife & Sons Co., Wm. B....144

Fire Clay
Air-Flex Co. 148
Harbison-Walker Refractories Co. 147
McLeod & Henry Co.....146

Firebox Blocks
Air-Flex Co.....148
Betson Plastic Fire Brick Co.144
Harbison-Walker Refractories Co. 147
McLeod & Henry Co.....146

Fittings, Ammonia
American Steam Gauge and Valve Mfg. Co.....70 and 71

Fittings, Steel
Nelson Valve Co.,.....135

Flanges
Ball & Wood Co.....158
Dart Mfg. Co., E. M.....133
Jefferson Union Co..... 10
National Tube Co.....126

Floats
Anderson Co., V. D..... 83
Schutte & Koerting Co.....133

Flue Gas Analysis Instruments
Pierce Co., Wm. B.....2d cover

Forgings, Drop
Williams & Co., J. H.....124

Furnace Door Arch
Air-Flex Co.....148
Betson Plastic Fire Brick Co.144
Harbison-Walker Refractories Co. 147
McLeod & Henry Co.....146

Furnace Linings
Harbison-Walker Refractories Co. 147

Furnaces, Smokeless
Green Engineering Co.....120
McClave-Brooks Co..... 14
Murphy Iron Works.....123
Vulcan Furnace Co.....122

Gage Boards
American Steam Gauge and Valve Mfg. Co.....70 and 71

Gage Glasses
Advance Packing & Supply Co. 86
American Steam Gauge and Valve Mfg. Co.....70 and 71
Cade & Knapp..... 84
Chesterton Co., A. W.....136
Garlock Packing Co..... 9
Jerguson Mfg. Co.....141
Peerless Rubber Mfg. Co..... 8
Rogers Co., H. A..... 84
Von Kokeritz & Co., R. G., 94 and 102

Gage Testing Outfit
American Steam Gauge and Valve Mfg. Co.....70 and 71
Star Brass Mfg. Co...90 and 91
Uehling Instrument Co.....144
Von Kokeritz & Co., R. G., 94 and 102

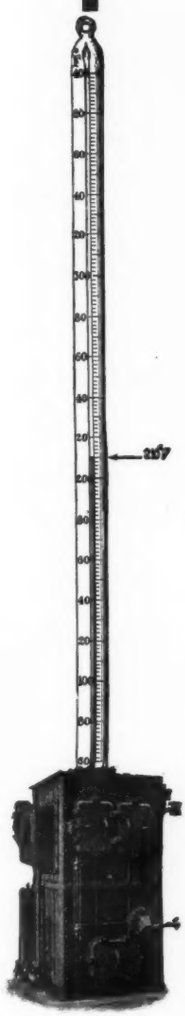
Gages, Draft
American Steam Gauge and Valve Mfg. Co.....70 and 71
Bristol Co.....4th cover
Star Brass Mfg. Co...90 and 91

Gages, Pressure
American Steam Gauge and Valve Mfg. Co.....70 and 71
Ashton Valve Co.....130
Crosby Steam Gage & Valve Co. 133
Star Brass Mfg. Co...90 and 91

Gages, Recording
American Steam Gauge and Valve Mfg. Co.....70 and 71
Ashton Valve Co.....130
Bristol Co.....4th cover
Ohio Injector Co.....130
Star Brass Mfg. Co...90 and 91
Uehling Instrument Co.....144

Gages, Vacuum
American Steam Gauge and Valve Mfg. Co.....70 and 71
Schutte & Koerting Co.....133
Star Brass Mfg. Co...90 and 91

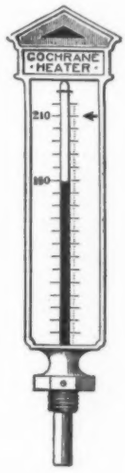
Gages, Water
American Steam Gauge and Valve Mfg. Co.....70 and 71
Greene, Tweed & Co., 101 and 4th cover
Huyette Co., Paul B.....12



How Hot Is Your Boiler Feed Water?
Every 10°F. = 1% of Fuel

In the majority of all steam plants, a good thermometer is worth more to the owner or operator of the plant; that is, will result in the saving of more money, than the steam engine indicator, and this conceding that the indicator is indispensable.

When it is considered that **every 10° F. which can be added to the temperature of the boiler feed supply means from 1% to 1.2% of the entire fuel bill,** it will become at once apparent that engineers and owners ought to have thermometer "indicators" at various stations in their steam power plant.



With a good thermometer you can check the vacuum gauge, determine the dryness of the steam, know whether you are getting the proper conditions for chemical reactions in a Hot Process Softening System, and determine a dozen other things that vitally affect steam plant economy.

A thermometer will prove to you that a **COCHRANE FEED WATER HEATER** is worth at least $50 more per 100 H.P. per year than is a closed heater, that is, the Cochrane Heater will give you, and constantly, the higher temperature, besides real purification.

A thermometer will show the value of the Cochrane Oil Separator for purifying exhaust steam before it passes to the heating or drying system, so that the warm condensed returns may be used for boiler feed at 120° to 150° F., instead of cold water at 60° F. Here again each 10° F. is 1% of the fuel bill.

A thermometer will enable you to determine accurately what back pressure you are carrying in the heating system, and to vary this back pressure, if need be, and you have the right kind of back pressure valve, to accommodate changes in the weather.

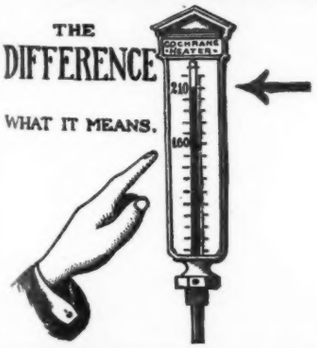
So important do we consider a thermometer to the proper appreciation of the superior value of Cochrane Steam and Oil Separators, Cochrane Feed Water Heaters, Cochrane Feed Water Heaters and Receivers, and Sorge-Cochrane Hot Process Water Softening Systems, that, for a limited time, we will sell thermometers at special prices to operating engineers complying with the conditions of the attached coupon.

Harrison Safety Boiler Works,

17th and Clearfield Streets, Philadelphia, Penna.

After May 1, 1911, our New England Office will be located at 1045 Oliver Bldg., Boston, Mass.

(*Tear off here and mail.*)



Enclosed herewith please find $1.50 for which please send me one Cochrane Hot Water Thermometer. The regular price is $3.00 to $3.50. Prices of other grades and of pocket thermometers upon application.

In consideration of the reduced price at which this thermometer is sold to me, I agree to insert the same in the boiler feed supply line from our . . . . . Feed Water Heater (*Make and type must be stated*) and to report to the **Harrison Safety Boiler Works** the readings for each hour during an average day's operation of the plant.

Name . . . . . .

Position . . . . . .

Firm . . . . . .

Address . . . . . .

Gages, Water—*Continued.*
Jenkins Bros. 75
Jerguson Mfg. Co. 141
Lunkenheimer Co. 4
Ohio Blower Co. 113
Ohio Brass Co. 128
Reliance Gauge Column Co. ..140
Star Brass Mfg. Co. ..90 and 91
Wright Mfg. Co. 82

Gas Exhausters
Ohio Blower Co. 113

Gas Producers
Bogart Gas Power Engineering Co. 152
Du Bois Iron Works 154
Foos Gas Engine Co. 154
Griscom-Spencer Co. 111
Minneapolis Steel & Mchy. Co. 152

Gaskets
American Goetze-Gasket and Packing Co. 95
Cincinnati Gasket & Packing Co. 94
Diamond Rubber Co. 94
Garlock Packing Co. 9
Greene, Tweed & Co., 101 and 4th cover
Jenkins Bros. 75
Johns-Manville Co., H. W. 97
Keeler Co., E. 140
New York Belting & Packing Co. 12
Peerless Rubber Mfg. Co. 8

Gears
New Process Raw Hide Co. ..116

Generating Sets
Foos Gas Engine Co. 154

Governors, Pump
Chaplin-Fulton Mfg. Co. 140
Elliott Co., 7, 83, 84, 97, 105, 108 and 134
Foster Engineering Co. 128
Mason Regulator Co. 132
Northern Equipment Co. 93
S—C Regulator Co. 80
Squires Co., C. E. 84
Watson & McDaniel Co. 88
Ziermore Regulator Co. 126

Governors, Pump Speed
Mason Regulator Co. 132
Ziermore Regulator Co. 126

Graphite
Dixon Crucible Co., Jos. 105
Garlock Packing Co. 9

Grates
Beggs & Co. 137
Casey-Hedges Co. 138
Cyclone Grate Bar Co. 119
Green Engineering Co. 120
Long Grate Bar Co. 120
McClave-Brooks Co. 14
Martin Grate Co. 121
Neemes Bros. 121
Perfection Grate Co. 119
Robertson & Sons, Jas. L. 79
Salamander Grate Bar Co. 121
Standard Grate Co. 120
Superior Iron Works Co. 123
Treadwell Co., M. H. 120
Washburn & Granger Co. 121

Grease
Albany Lubricating Co. .104, 105
Dearborn Drug & Chemical Works 5
Dixon Crucible Co., Jos. 105
Keystone Lubricating Co. 3
N. Y. & N. J. Lub. Co. 99
Philadelphia Grease Mfg. Co. 103
Royersford Fdry. & Mach. Co. 117
Walton Co., F. S. ..... 16 and 17

Grease Extractors
Beggs & Co. 137
Elliott Co., 7, 83, 84, 97, 105, 108 and 134
Griscom-Spencer Co. 111

Heaters and Purifiers, Feed Water
Alberger Condenser Co. 88
Barngwanath & Son, Wm. 108
Bates Machine Co. 158
Beggs & Co. 137
Blake & Knowles Steam Pump Works 110
Casey-Hedges Co. 138
Elliott Co., 7, 83, 84, 97, 105, 108 and 134
Griscom-Spencer Co. 111
Harrison Safety Boiler Wks. . 73
Hoppes Mfg. Co. 110
Minneapolis Steel & Mchy. Co. 152
National Pipe Bending Co. 111
Open Coil Heater & Purifier Co. 108
Patterson & Co., Frank L., 106 and 107
Robertson & Sons, Jas. L. 75
Wheeler Mfg. Co., C. H. 87
Whitlock Coil Pipe Co. 128
Wickes Boiler Co. 140
Williams Tool Co. 109

Heating and Ventilating Systems
Ohio Blower Co. 113
Schutte & Koerting Co. 133
Wing Mfg. Co., L. J. 124

Heating, Central Station
American District Steam Co. .109

Hoists, Combustion Engine
Foos Gas Engine Co. 154

Hoists, Electric
Allis-Chalmers Co. 89
Yale & Towne Mfg. Co. 126

Hoists, Hand
Yale & Towne Mfg. Co. 126

Hose, Metal
American Metal Hose Co. 156
Pennsylvania Flexible Metallic Tubing Co. 84

Hose, Rubber
Diamond Rubber Co. 94
Garlock Packing Co. 9
Lagonda Mfg. Co. ..... 3d cover
Liberty Mfg. Co. 7
New York Belting & Packing Co. 12
Peerless Rubber Mfg. Co. 8
Rhoads & Sons, J. E. 114

Ice and Refrigerating Machinery
Vilter Mfg. Co. 159
Vogt Machine Co. 138
Watts-Campbell Co. 157

Ice Machine Repairs
Underwood & Co., H. B. 158

Indicators, Ammonia
American Steam Gauge and Valve Mfg. Co. ..... 70 and 71
Star Brass Mfg. Co. ..... 90 and 91

Indicators, Combustion Engine
American Steam Gauge and Valve Mfg. Co. ..... 70 and 71
Star Brass Mfg. Co. ..... 90 and 91
Trill Indicator Co. 81

Indicators, Speed
Star Brass Mfg. Co. ..... 90 and 91
Starrett Co., L. S. 120

Indicators, Steam Engine
American Steam Gauge and Valve Mfg. Co. ..... 70 and 71
Crosby Steam Gage & Valve Co. 133
Robertson & Sons, Jas. L. 79
Star Brass Mfg. Co. ..... 90 and 91
Trill Indicator Co. 81

Injectors
American Injector Co. 126
Jenkins Bros. 75
Lunkenheimer Co. 4
Ohio Injector Co. 130
Penberthy Injector Co. 13
Robertson & Sons, Jas. L. 79
Schutte & Koerting Co. 133

Lamps, Electric
General Electric Co. 112
Johns-Manville Co., H. W. 97

Lathes, Foot Power
Barnes Co., W. F. & John. 138

Lubricators, Cylinder
Detroit Lubricator Co. 102
Flower Co., Walter L. 105
Greene, Tweed & Co., 101 and 4th cover
Griscom-Spencer Co. 111
Lunkenheimer Co. 4
Manzel Bros. Co. 103
Ohio Injector Co., The. 102
Richardson-Phenix Co. 100
Robertson & Sons, Jas. L. 79
Star Brass Mfg. Co. ..90 and 91
Universal Lubricator Co. 15

Lubricators, Force Feed
Greene, Tweed & Co., 101 and 4th cover
Lunkenheimer Co. 4
Richardson-Phenix Co. 100
Star Brass Mfg. Co. ..90 and 91

Mats and Matting
Diamond Rubber Co. 94
New York Belting & Packing Co 12
Peerless Rubber Mfg. Co. 8

Metal, Bearing
Magnolia Metal Co. 152

Meters, Coal
Howard Co., O. D. 123

Meters, Steam
General Electric Co. 112
St. John, G. C. 138

Meters, Water
Builders Iron Foundry 97

Micrometers
Starrett Co., L. S. 120

Milling Machines, Portable
Underwood & Co., H. B. 158

Motors, Electric
Allis-Chalmers Co. 89
American Engine Co. 157
Crocker-Wheeler Co. 93
General Electric Co. 112
Ridgway Dynamo & Engine Co 157
Sturtevant Co., B. F. 139

Motors, Water
Elliott Co., 7, 83, 84, 97, 105, 108 and 134
Lagonda Mfg. Co. ..... 3d cover

Oil and Grease Cups
Albany Lubricating Co. .104, 105
American Injector Co. 126
Detroit Lubricator Co. 102
Elliott Co., 7, 83, 84, 97, 105, 108 and 134
Griscom-Spencer Co. 111
Keystone Lubricating Co. 3
Lunkenheimer Co. 4
New York & New Jersey Lubricant Co. 99
Ohio Injector Co. 130
Star Brass Mfg. Co. ..90 and 91
Universal Lubricator Co. 15

Oil Burners
Hammel Oil Burner Co. 123
Lunkenheimer Co. 4
Parson Mfg. Co. 121

Oil Reservoirs
Burt Mfg. Co. 18
Richardson-Phenix Co. 100

Oil Tanks
Richardson-Phenix Co. 100

Oiling Systems
Albany Lubricating Co. .104, 105
Burt Mfg. Co. 18
Detroit Lubricator Co. 102
Elliott Co., 7, 83, 84, 97, 105, 108 and 134
Lunkenheimer Co. 4
Richardson-Phenix Co. 100

Oils
Albany Lubricating Co. .104, 105
Dearborn Drug & Chemical Works 5
New York & New Jersey Lubricant Co. 99
Walton Co., F. S. ..... 16 and 17

Packing, Flange
Advance Packing & Supply Co. 86
American Goetze-Gasket & Packing Co. 95
Cancos Mfg. Co. 94
Chesterton Co., A. W. 136
Cincinnati Gasket & Packing Co. 94
Danubil Co. 96
Diamond Rubber Co. 94
Eureka Packing Co. 78
Garlock Packing Co. 9
Greene, Tweed & Co., 101 and 4th cover
Jenkins Bros. 75
Johns-Manville Co., H. W. 97
New York Belting & Packing Co. 12
Peerless Rubber Mfg. Co. 8
Rhoads & Sons, J. E. 114
Smooth-On Mfg. Co. 6
Thermoid Rubber Co. 11
Von Kokeritz & Co., R. G. .94, 102

Packing, Hydraulic
Advance Packing & Supply Co. 86
Danubil Co. 96
Johns-Manville Co., H. W. 97
Von Kokeritz & Co., R. G. .94, 102

Packing, Pump Valve
Cincinnati Gasket & Packing Co. 94
Diamond Rubber Co. 94
Von Kokeritz & Co., R. G. .94, 102

Packing, Rod
Advance Packing & Supply Co. . 86
American Goetze-Gasket and Packing Co. 95
Cancos Mfg. Co. 94
Chesterton Co., A. W. 136
Cincinnati Gasket & Packing Co. 94
Danubil Co. 96
Diamond Rubber Co. 94
Eureka Packing Co. 78
Flower Co., W. L. 105
Garlock Packing Co. 9
Greene, Tweed & Co., 101 and 4th cover
Johns-Manville Co., H. W. 97
New York Belting and Packing Co 12
Peerless Rubber Mfg. Co. 8
Power Specialty Co. 84
Thermoid Rubber Co. 11
Von Kokeritz & Co., R. G. .94, 102

Pipe
Ball & Wood Co. 158

Pipe Bending
Ball & Wood Co. 158
National Pipe Bending Co. 111
Whitlock Coil Pipe Co. 128

Pipe Clamp
Yarnall-Waring Co. 134

Pipe Coils
National Pipe Bending Co. 111
National Tube Co. 126
Whitlock Coil Pipe Co. 128

Pipe Cutting and Threading Machines
Armstrong Mfg. Co. 126
Bignall & Keeler Mfg. Co. 126
Borden Co. 126
Curtis & Curtis Co. 131
Toledo Pipe Threading Machine Co. 128
Trimont Mfg. Co. ....118 and 150

Pipe Joints
Dixon Crucible Co., Jos. 105

Pipe, Riveted Steel
Kennicott Co., The. 93

Piping, Blower
Ohio Blower Co. 113

Planimeters
American Steam Gauge and Valve Mfg. Co. ..... 70 and 71
Robertson & Sons, Jas. L. 79
Trill Indicator Co. 81

Polish, Metal
Hoffman, Geo. W. 156
Johns-Manville Co., H. W. 97

Publishers
International Corr. Schools. .. 77
McGraw-Hill Book Co. 98

Pulleys
Minneapolis Steel & Mchy. Co. 152
Saginaw Mfg. Co. 118

Pumps, Air
Cameron Steam Pump Wks., A. S. 89
Deane Steam Pump Co. 86
Deming Co. 88
Du Bois Iron Works. 154
Wheeler Mfg. Co., C. H. 87

Pumps, Centrifugal
Alberger Condenser Co. 88
Allis-Chalmers Co. 89
De Laval Steam Turbine Co. . 153
Deane Steam Pump Co. 86
Deming Co. 88

Pumps, Deep Well
Cameron Steam Pump Wks., A. S. 89
Deane Steam Pump Co. 86
Deming Co. 88

Pumps, Electric
De Laval Steam Turbine Co. . 153
Du Bois Iron Works. 154

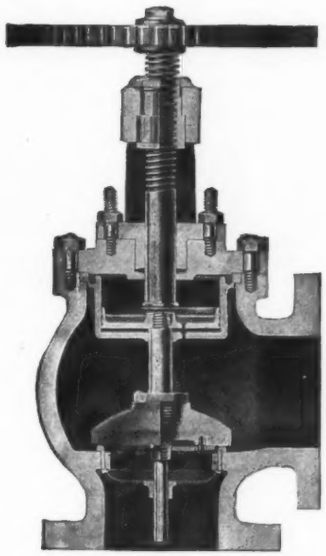
Pumps, Oil
Burt Mfg. Co. 18
Cameron Steam Pump Wks., A. S. 89
Deane Steam Pump Co. 86
Du Bois Iron Works. 154
Lunkenheimer Co. 4
Manzel Bros. Co. 102
Richardson-Phenix Co. 100
Star Brass Mfg. Co. ..90 and 91

Pumps, Oil Force-feed
Deane Steam Pump Co. 86
Detroit Lubricator Co. 102
Lunkenheimer Co. 4
Richardson-Phenix Co. 100

Pumps, Pneumatic
Ingersoll-Rand Co. 100

Pumps, Power
Deane Steam Pump Co. 86
Deming Co. 88
Du Bois Iron Works. 154
Patterson & Co., Frank L., 106 and 107
Perkins Co., Jno. B. 129
Union Steam Pump Co. 89
Whitlock Coil Pipe Co. 128

Pumps, Steam
Cameron Steam Pump Wks., A. S. 89
Deane Steam Pump Co. 86
De Laval Steam Turbine Co. . 153
Du Bois Iron Works. 154
Epping-Carpenter Co. 89
Ingersoll-Rand Co. 100
Jamieson & Co., M. W. 88
Minneapolis Steel & Mchy. Co. 152
Perkins Co., Jno. B. 129
Union Steam Pump Co. 89
Wheeler Mfg. Co., C. H. 87



Automatic Equalizing Stop and Check Valves—Extra Heavy Pattern

IF a tube should burst in a boiler, or some other internal rupture take place that would suddenly reduce the pressure in that particular boiler the Jenkins Bros. Automatic Equalizing Stop and Check Valve would immediately shut off the flow of steam from the header into the boiler.

But they are more than emergency valves — they equalize the pressure between the different boilers in a battery so that no one boiler will be working at a lower pressure than another.

They can only be opened by pressure in the boiler to which they are attached so that no steam can accidentally be turned into any boiler while it is being cleaned. They are thoroughly modern, have full opening, and are made strong and rigid to withstand the strains due to expansion and contraction of the piping.

They are cushioned to prevent hammering or chattering; are tested to 800 lbs. hydraulic pressure and guaranteed for working steam pressures up to 250 lbs.

Furnished in extra Heavy Pattern in all sizes from 4″ to 12″ either screwed or flanged.

Write for special bulletin giving full details.

Jenkins Bros.

80 White St., New York 35 High St., Boston 133 N. 7th St.. Philadelphia
300 West Lake St., Chicago

Pumps, Vacuum
Alberger Condenser Co..... 88
Cameron Steam Pump Wks., A. S..... 89
Deane Steam Pump Co..... 86
Union Steam Pump Co..... 89
Wheeler Mfg. Co., C. H..... 87

Pyrometers
American Steam Gauge and Valve Mfg. Co.....70 and 71

Rams, Steam
Penberthy Injector Co..... 13

Reducing Wheels
American Steam Gauge and Valve Mfg. Co.....70 and 71
Robertson & Sons, Jas. L..... 79
Star Brass Mfg. Co...90 and 91
Trill Indicator Co..... 81

Regulators, Damper
Elliott Co., 7, 83, 84, 97, 105, 108 and 134
Lagonda Mfg. Co.....3d cover
Mason Regulator Co.....132
Robertson & Sons, Jas. L..... 79
Turbo-Blower Co. 123

Regulators, Feed Water
Cade & Knapp..... 84
Elliott Co., 7, 83, 84, 97, 105, 108 and 134
Lagonda Mfg. Co.....3d cover
Mason Regulator Co.....132
Murray Automatic Boiler Feed Co. 144
Northern Equipment Co..... 93
S—C Regulator Co..... 80
Squires Co., C. E..... 84
Ziermore Regulator Co.....,126

Regulators, Pressure
American District Steam Co..100
Chaplin-Fulton Mfg. Co.....140
Elliott Co., 7, 83, 84, 97, 105, 108 and 134
Foster Engineering Co.....128
Hughson Steam Specialty Co..134
Mason Regulator Co.....132
Northern Equipment Co..... 93
Ohio Brass Co.....128
Squires Co., C. E..... 84
Steam Appliance Co..... 83
Ziermore Regulator Co.....126

Regulators, Pump
Elliott Co., 7, 83, 84, 97, 105, 108 and 134
Hughson Steam Specialty Co.134
Mason Regulator Co.....132
Squires Co., C. E..... 84
Ziermore Regulator Co.....126

Revolution Counters
American Steam Gauge and Valve Mfg. Co.....70 and 71
Schuchardt & Schutte.....126

Rheostats
General Electric Co.....112

Roller Bearings
Royersford Fdry. & Mach. Co.117

Rope, Transmission
American Mfg. Co.....4th cover
Columbian Rope Co.....118

Rubber Joints
Diamond Rubber Co..... 94

Rules
Johnson Rule Mfg. Co., E. P..123

Saddles
Lisk, Jos. P..... 97

Second Hand Machinery
Ault & Wiborg Co..... 84

Separators, Ammonia
Elliott Co., 7, 83, 84, 97, 105, 108 and 134
Harrison Safety Boiler Wks.. 73

Separators, Oil
Austin Separator Co..... 82
Baragwanath & Son, Wm.....108
Direct Separator Co..... 83
Elliott Co., 7, 83, 84, 97, 105, 108 and 134
Harrison Safety Boiler Wks.. 73
Hoppes Mfg. Co.....110
Ohio Blower Co.....113
Robertson & Sons, Jas. L..... 79
Ruggles Co., Walter G..... 92
Steam Appliance Co..... 83
Wright Mfg. Co..... 82

Separators, Steam
Austin Separator Co..... 82
Baragwanath & Son, Wm....108
Direct Separator Co..... 83
Elliott Co., 7, 83, 84, 97, 105, 108 and 134
Griscom-Spencer Co.....111
Harrison Safety Boiler Wks.. 73
Hoppes Mfg. Co.....110

Separators, Steam—*Continued.*
Ohio Blower Co.....113
Patterson & Sons, Jas. L..106, 107
Robertson & Sons, Jas. L..... 79
Steam Appliance Co..... 83
Whitlock Coil Pipe Co.....128
Wright Mfg. Co..... 82

Shaft Hangers
Royersford Fdry. & Mach. Co.117

Shafting, Alining and Leveling Apparatus
Kinkead Mfg. Co.....118

Sight Feeds
Richardson-Phenix Co.....100

Skylights
Burt Mfg. Co..... 18

Stokers, Chain Grate
Green Engineering Co.....130

Stokers, Mechanical
American Ship Windlass Co..125
Babcock & Wilcox Co.....138
Green Engineering Co.....130
McClave-Brooks Co..... 14
Murphy Iron Works.....123
Parson Mfg. Co.....121
Under-Feed Stoker Company of America 124
Vulcan Furnace Co.....122
Westinghouse Machine Co....162

Strainers, Pump Suction
American Ship Windlass Co..125
Elliott Co., 7, 83, 84, 97, 105, 108 and 134

Strainers, Water
Elliott Co., 7, 83, 84, 97, 105, 108 and 134

Superheaters
Babcock & Wilcox Co.....138
Parker Boiler Co..... 93
Power Specialty Co..... 89
Providence Engineering Wks.158

Switchboards
General Electric Co.....112

Switches, Electric
General Electric Co.....112

Tachometers
Schuchardt & Schutte.....126

Tanks
Griscom-Spencer Co.....111
Kennicott Co., The..... 93

Taps, Stocks and Dies
Armstrong Mfg. Co.....126
Bignall & Keeler Mfg. Co....126
Curtis & Curtis Co.....131

Thermometers
Bristol Co.....4th cover

Tools, Portable Repair
Underwood & Co., H. B.....158

Transformers and Converters
General Electric Co.....112

Traps, Steam
American District Steam Co..100
Anderson Co., V. D..... 83
Chaplin-Fulton Co.....140
Elliott Co., 7, 83, 84, 97, 105, 108 and 134
Griscom-Spencer Co. 111
Jenkins Bros..... 75
Harrison Safety Boiler Wks.. 73
Morehead Mfg. Co..... 82
Nashua Machine Co..... 83
Newhall Engr. Co., Geo. M... 85
Ohio Blower Co.....113
Open Coil Heater & Purifier Co 108
Reliance Gauge Column Co...140
Schutte & Koerting Co.....133
Squires Co., C. E..... 84
Star Brass Mfg. Co...90 and 91
Steam Appliance Co..... 83
Watson & McDaniel Co..... 88
Wright Mfg. Co..... 82

Traps, Vacuum
Griscom-Spencer Co. 111
Morehead Mfg. Co..... 82
Nashua Machine Co..... 83
Open Coil Heater & Purifier Co.108

Tube Cap Reseating Machines
Lagonda Mfg. Co.....3d cover
Liberty Mfg. Co..... 7

Tube Cleaners
Bayer Steam Soot Blower System 151
Chesterton Co., A. W.....136
Diamond Power Specialty Co.117
Elliott Co., 7, 83, 84, 97, 105, 108 and 134
Garlock Packing Co..... 9
Johns-Manville Co., H. W.... 97
Lagonda Mfg. Co.....3d cover

Tube Cleaners—*Continued.*
Liberty Mfg. Co..... 7
Pierce Co., Wm. B.....2d cover
Robertson & Sons, Jas. L.... 79
St. John, G. C.....138
Simonds & Co., G. L.....149
Steam Appliance Co..... 83
Vulcan Soot Cleaner Co.....149

Tube Cutters
Lagonda Mfg. Co.....3d cover
Liberty Mfg. Co..... 7

Tubing
Johns-Manville Co., H. W.... 97
National Tube Co.....126

Tubing, Metallic
Pennsylvania Flexible Metallic Tubing Co. 84

Turbines, Hydraulic
Allis-Chalmers Co..... 89

Turbines, Steam
Allis-Chalmers Co..... 89
De Laval Steam Turbine Co..153
General Electric Co.....112
Hooven, Owens, Rentschler Co.159
Sturtevant Co., B. F.....139
Westinghouse Machine Co....162

Unions
Dart Mfg. Co., E. M.....133
Jefferson Union Co..... 10
Lunkenheimer Co..... 4
National Tube Co.....126

Valve Balls
Diamond Rubber Co..... 94

Valve Disks
American Goetze-Gasket Packing Co..... 95

Valve Reseating Machines
Leavitt Machine Co.....127

Valve Washers, Leather
Schieren Co., Chas. A...1st cover

Valves, Ammonia
Chapman Valve Mfg. Co.....132
Monarch Valve & Mfg. Co....134

Valves, Angle
Golden-Anderson Valve Specialty Co. 132
Homestead Valve Mfg. Co....132
Lunkenheimer Co..... 4
Monarch Valve & Mfg. Co....134
National Tube Co.....126
New Bedford Valve Mfg. Co..132

Valves, Back Pressure
Foster Engineering Co.....128
Hughson Steam Specialty Co.134
Jenkins Bros..... 75
Perkins Co., Jno. B.....129
Ruggles Co., Walter G..... 92

Valves, Blow-off
Elliott Co., 7, 83, 84, 97, 105, 108 and 134
Homestead Valve Mfg. Co....132
Jenkins Bros..... 75
Lunkenheimer Co..... 4
Yarnall-Waring Co. 134
Ziermore Regulator Co.....126

Valves, By-Pass
Nelson Valve Co.....135

Valves, Check
Greene, Tweed & Co., 101 and 4th cover
Jenkins Bros..... 75
Lunkenheimer Co..... 4
National Tube Co.....126
Nelson Valve Co.....135

Valves, Cylinder Relief
American Steam Gauge and Valve Mfg. Co.....70 and 71
Lunkenheimer Co..... 4
Nelson Valve Co.....135
Perkins Co., Jno. B.....129
Star Brass Mfg. Co...90 and 91

Valves, Exhaust Relief
Alberger Condenser Co..... 88
Jenkins Bros..... 75
Nelson Valve Co.....135

Valves, Float
Golden-Anderson Valve Specialty Co. 132

Valves, Free Exhaust
Schutte & Koerting Co.....126

Valves, Gate
Chapman Valve Mfg. Co.....132
Detroit Lubricator Co.....102
Greene, Tweed & Co., 101 and 4th cover
Jenkins Bros..... 75
Lunkenheimer Co..... 4
National Tube Co.....126
Nelson Valve Co.....135
Pittsburgh Valve, Fdry. & Construction Co.....132

Valves, Globe
Detroit Lubricator Co.....102
Golden-Anderson Valve Specialty Co. 132
Jenkins Bros..... 75
Lunkenheimer Co..... 4
National Tube Co.....126
Nelson Valve Co.....135
New Bedford Valve Mfg. Co..132
Pittsburgh Valve, Fdry. and Construction Co.....135
Star Brass Mfg. Co...90 and 91

Valves, Piston
Baker Valve Co.....156

Valves, Pump
Garlock Packing Co..... 9
Jenkins Bros..... 75
New York Belting & Packing Co. 12
Peerless Rubber Mfg. Co..... 8

Valves, Reducing
Mason Regulator Co.....132
Star Brass Mfg. Co...90 and 91

Valves, Regrinding
Lunkenheimer Co..... 4
National Tube Co.....126
Nelson Valve Co.....135

Valves, Regulating
Hughson Steam Specialty Co.134
Lunkenheimer Co..... 4
Mason Regulator Co.....132
Nelson Valve Co.....135
Steam Appliance Co..... 83
Ziermore Regulator Co.....126

Valves, Return Stop
Lagonda Mfg. Co.....3d cover

Valves, Safety
American Steam Gauge and Valve Mfg. Co.....70 and 71
Ashton Valve Co.....130
Crosby Steam Gage & Valve Co. 133
Detroit Lubricator Co.....102
Jenkins Bros..... 75
Lunkenheimer Co..... 4
National Tube Co.....126
Pittsburgh Valve, Fdry. and Construction Co.....132
Star Brass Mfg. Co...90 and 91

Valves, Safety Stop
Foster Engineering Co.....128

Valves, Stop Check
Jenkins Bros..... 75
Lagonda Mfg. Co.....3d cover
Perkins Co., Jno. B.....129
Schutte & Koerting Co.....133

Valves, Superheated Steam
Chapman Valve Mfg. Co.....132
Lunkenheimer Co..... 4
Nelson Valve Co.....135

Valves, Tank
Nelson Valve Co.....135

Valves, Throttle
Detroit Lubricator Co.....102

Valves, Trip Throttle
Schutte & Koerting Co.....133

Ventilators
Burt Mfg. Co..... 18
Ohio Blower Co.....113
Schutte & Koerting Co.....133
Turbo-Blower Co.....123
Wing Mfg. Co., L. J.....124

Vises
Armstrong Mfg. Co.....126

Water Columns
American Steam Gauge and Valve Mfg. Co.....70 and 71
Elliott Co., 7, 83, 84, 97, 105, 108 and 134
Huyette Co., P. B.....124
Lunkenheimer Co..... 4
National Tube Co.....126
Reliance Gauge Column Co...140
Robertson & Sons, Jas. L..... 79
Wright Mfg. Co..... 82

Water Softening Apparatus
Harrison Safety Boiler Wks.. 73
Kennicott Co., The..... 93
Scaife & Sons Co., Wm. B....144

Whistles
American Steam Gauge and Valve Mfg. Co.....70 and 71
Lunkenheimer Co..... 4
Star Brass Mfg. Co...90 and 91

Wrenches, Nut and Bolt
Trimont Mfg. Co...118 and 150
Williams & Co., J. H..... 109

Wrenches, Pipe
Trimont Mfg. Co...118 and 150
Williams & Co., J. H.....109

Now Chief Engineer

Salary Increased 450 Per Cent

Mr. J. Edgar Williams, 315 Cable St., Indianapolis, Ind., writes to the I. C. S., January 27, 1911, as follows:

"A Representative of the I. C. S. came to me one day when I had charge of a plant running only part time. He put the Correspondence School proposition up to me in such a way that I heard plainly the knocking of Opportunity. I purchased a Course in Engine Running and began to study. Night after night, while the little ones were in dreamland, I dug into the technicalities of Steam Engineering. I went at the work with just one aim—to win. I have won. My reward is being gathered each week as I receive my weekly pay envelope with earnings increased 450 per cent. over what they were when I enrolled.

"I now have charge of a new and well equipped plant of about 800 H.P. There are two water tube boilers; 2 engines (one a compound corliss condensing engine); 1 alternator, 220 volts; 1 direct current machine, 110 volts; 5 motors; and 7 steam pumps. I have full charge of the steam electric part of the plant, in which from 5 to 8 men are employed.

"I feel that my progress has been owing entirely to the preparation I got from the I. C. S. My I. C. S. diploma is prized more highly by me than any other honor I have ever received. To succeed, any one able to read and write needs only pluck, push, perseverance, and a Course with the I. C. S."

This is just another of the many thousand examples of the salary-raising power of the I. C. S.

Every month there are received at the I. C. S. over 400 letters from men and women voluntarily reporting salaries raised and positions bettered through study of I. C. S. Courses. Such results are not due to chance. They are the reward for conscientious effort. And such results must appeal to industrious, laboring people.

Because of the great industrial development during recent years, there is a crying demand for trained men. If you are thoroughly trained in your work, you are needed everywhere.

One man sells his labor and receives for it $1.50 a day; another sells his knowledge and from it receives from $1,000 to $5,000 or more a year. The result of this difference is that the one ekes out a mere living, while the other enjoys a happy and contented life. The I. C. S. is ready and willing to help you out of the $1.50 a day class. Are you willing to be helped? **Then mark and mail the attached coupon.**

International Correspondence Schools

Box 939, SCRANTON, Pa.

Please explain, without further obligation on my part, how I can qualify for a larger salary and advancement to the position, trade, or profession before which I have marked X

Electrical Engineer	Machinist	Chemist
Electrical Mach. Des.	Toolmaking	Assayer
Dynamo Foreman	Molding	Commer'l Illustrat'g
Electrical Lighting	Blacksmithing	Bookkeeper
Electric Railways	Civil Engineer	Stenographer
Electrician	Stationary Engineer	Civil Service Exams.
Telephone Expert	Gas Engineer	Commercial Law
Concrete Construct'n	Refrigeration Eng.	Architecture
Mechanical Engineer	Sheet-Metal Drafts.	Contracting & B'ld'g
Machine Designer	Marine Engineer	Advertising Man
Mechanical Draft.	Mining Engineer	Window Trimming
Patternmaking	Structural Engineer	Automobile Running

Name .....

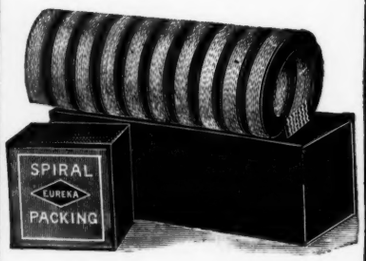
Street and No. .....

City ..... *State* .....

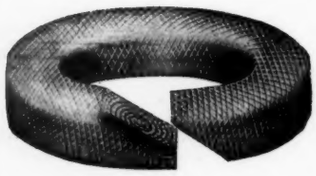
Present Occupation .....

PATENTED
EUREKA
TRADE MARK

Gum Core



Spiral



High Pressure Ring

Expansion Ring

Red Core Ring

The Packing That Is Correct In Principle—Correct In Construction—Correct In Material

EUREKA

Genuine Eureka Gum Core Packing is a lively packing, it never loses its give and take qualities—made as it is, with a rubber centre and a thoroughly lubricated braided flax covering, it will maintain a tight joint without being set up hard. It will keep rods steam tight and working free that are scored,—worn or fluted—for it will conform to their irregularities and resume its shape, but it will never grip or bind any rod.

No packing made for the purpose that **Genuine Eureka** Gum Core Packing is made (any pressure up to 125 lbs.) is of better material or better constructed. None can give equal service that Eureka Packing gives, yet—**Genuine Eureka** sells for half as much as the next best packing to it.

A high grade packing sold at a low price. A packing that saves rods, saves your time and cuts down your packing troubles as well as packing cost.

You try **Genuine Eureka** and you will quickly come to know its betterness.

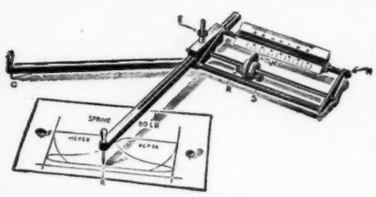
Say to your dealer **Genuine Eureka**—if he does not carry it—send direct to us; we pay carriage charges on 10 lbs. or over anywhere **East or South of Omaha.**

You get just another such square deal with Eureka Spiral—High Pressure Ring, Expansion Ring, Red Core Ring Packing.

The Eureka Packing Co.

James L. Robertson, Pres.

76-78 Murray St., New York City



Price counts here, for a month—we send you This Planimeter reads

FIVE DOLLARS cannot be better invested to win your PROMOTION. It obtains the best Indicator Outfit you can buy—the

ROBERTSON-THOMPSON

To know to a certainty what is happening in the cylinder of your engine, if the valves are set correctly, if the piston leaks, if there is fuel waste per horse power and if you are getting the right initial pressure in the cylinder in accordance with Boiler pressure, you must employ an Indicator outfit and the instruments must be accurate and reliable.

Without qualification, you can secure no better made—no more accurate, durable or handsome Instruments than THE ROBERTSON-THOMPSON INDICATOR AND VICTOR REDUCING WHEEL, or a more complete outfit than we offer for $50.00—$5.00 down and $5.00 a month. There are no extras needed.

We back up the durability of the Robertson-Thompson instruments by telling you that if at any time after you purchase them, should any part of the Robertson-Thompson Indicator and Victor Reducing Wheel become deranged through defective workmanship or material that we will replace them free of cost. We would not do this if we did not know our Instruments will give you wear and are absolutely accurate.

Send us $5.00 and a few references and we send you the outfit and you can keep and EXAMINE it for five days. If all is not as you expected, send it back and we will return your money.

We make this liberal offer for $50.00 —terms $5.00 down and $5.00 a month.

THE ROBERTSON-THOMPSON OUTFIT, Indicator and Reducing Wheel, packed in handsome hardwood case, with lock and key and nickel-plated trimmings, and fitted with extra ¼" area piston, detent motion, two springs as selected, either one three way or two straight way cocks, cord, card, oiler, scales, book of instructions, etc. Exactly as shown in cut.

If interested sign coupon and we will send you full details and an Engineer's log book FREE.

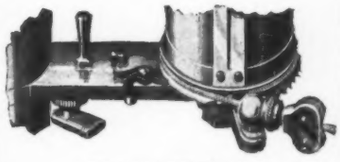
Jas. L. Robertson & Sons

James L. Robertson, Pres.

76-78 Murray St., New York City

THE ROBERTSON THOMPSON INDICATOR

The Indicator



Detent Motion

Reducing Wheel

Complete Outfit

$12.50—$2.50 down and $1.25 The Improved Willis Planimeter. M. E. P. direct without figuring.

Send me a FREE copy of the ROBERTSON Log Book and full details of the ROBERTSON-THOMPSON INDICATOR OUTFIT offer.

Name.....

Address.....

Firm's Name.....

P. No. 57

Don't Oppose Modern Methods Fall In Line

Ten Little Talks With The Engineer On Central Station Service. Watch For One Each Week.

The First Of Them

The *successful* man is the man who reads the signs of the times and takes advantage of the *new* opportunities offered by *changed* conditions.

Ways of living change with lightning rapidity; each succeeding year finds people demanding new and bigger and better things. For the ways of Yesterday have—almost over night—become inadequate for meeting the needs of Today.

The great American city with its thousands of buildings and hundreds of thousands of people all brought together in one small space is a *new* way of living. Great office buildings towering up story-upon-story, huge department stores, the city factory, monster apartment buildings, are all products of the past few years.

They are new ways of Today; and the way of Yesterday, the old method of lighting and heating and supplying power to these modern buildings, has become inadequate. A new way—a way bigger and better—is demanded. *And that new and bigger and better way is Central Station Service.*

The signs of the times are unmistakable. Central Station Service, called into being because of the inadequacy of the old method, is *bound* to dominate the heating and lighting and power field in great cities like New York. It is the natural and inevitable result.

And what of the *engineer*? The same outcome for him as for any other man in any other field. To oppose and fight the inevitable modern way, spells certain failure. But intelligently to take advantage of the greater opportunities offered is to win an equally certain and far greater success than was possible under old conditions. And those who first seize these new opportunities will win the greatest successes.

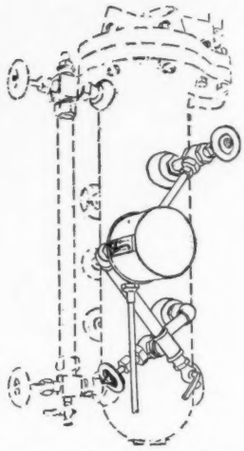
Don't oppose modern methods. Fall in line.

Why not find out just what new opportunities the Edison Service holds for you? A telephone call—number Worth 3000—will bring full information.

The New York Edison Co.
55 Duane St., New York City

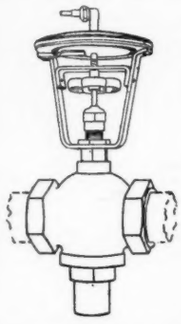
We Guarantee Results

Our guarantee that "S-C" Regulators will keep the water level within one inch of any desired point is the same as guaranteeing higher boiler efficiency, fuel economy and boiler safety.



For you can set the "S-C" Regulator to keep the water at the Middle Gauge and *it will do it.* It has no floats, needle valves, or other intricate parts to get out of order.

And water level at the middle gauge means dry expansive steam for the engine, full use of fuel efficiency, and elimination of danger from low water in the boiler.



The *most* efficient and *most lastingly* efficient regulator. *Write for full particulars.*

The "S-C" Regulator Co.
303 Perry Street Fostoria, Ohio

EVERY engineer is vitally concerned in the economy and efficiency of his plant.

As he reduces expenses and promotes efficiency he is rated a good or an indifferent engineer.

Power plant machinery and appliances are built to produce greater economy and efficiency.

And in this selling section are shown the best machines and devices in the power field.

Investigate and learn more about them.

Smashing The Indicator Market With A Splendid Instrument Backed By A Wonderful Offer

Every once in a while a really big opportunity arises which means satisfaction for those who grasp it.

Such an opportunity is now before you. Never, since Indicators have been made and sold, has come such an unusual chance to become the owner of one. Never has owning your own Indicator been made so easy. Never has a high-grade, accurate and reliable Indicator, such as the "Trill," been offered on such liberal terms—terms by which the makers of the instrument *help you pay for it.*

$5 Down—$5 A Month

Look at this certificate. Read it. By its terms you can see how we help you pay for your "Trill" Indicator and Outfit. It has a face value of $5.00, if used according to instructions. We offer it to you *free*, provided you send us the coupon. A better Indicator than the "Trill" does not exist. You could not own one of which you would be more proud, or one which would give you more accurate diagrams. In workmanship, finish and quality the "Trill" is the best that money can buy.

The "Trill" Triumph Indicator with Inside Spring, Case, two Springs, two Straight Cocks, Scales, etc., for steam, costs $40.00. The same Indicator with the same equipment, but with Outside Spring (as shown) costs $55.00. Both sold on the easy-payment-plan of $5 down and $5 a month.

THIS CERTIFICATE is worth $5.00
IF USED ACCORDING TO INSTRUCTIONS
WE will pay $5.00 for this Certificate if accompanied with a set of Indicator diagrams taken as your engine is running, and also a set of cards taken after your Trill Triumph Indicator tells you how to adjust it.
This offer applies only to purchasers of Trill Triumph Indicators.

This is a fac-simile of the certificate—not to be torn out of this ad.

Send The Coupon And Get Your Certificate

When somebody comes along and offers you the best Indicator made, on easy instalment payments, and then, in addition, offers to help you pay for it, *why refuse?* More and more Engineers are owning Indicators every day because modern conditions demand that the progressive Engineer—the *advancing* kind—shall own his own Indicator Outfit. Sooner or later *you* will feel the pressure. Are you going to let such an easily acquired thing as a "Trill" Indicator stand between you and advancement in your profession?

Will you let us place this free Certificate in your hands, together with the full story of *why* the "Trill" Indicator is the best indicator to own and use? Writing for the Certificate places you under no obligation and even if you do not seriously intend making *immediate* use of it, it is a valuable thing to have in your possession—as a reminder of this offer. Chances like this come once in a "blue moon." Act right now.

Trill Indicator Co., Corry, Pa.

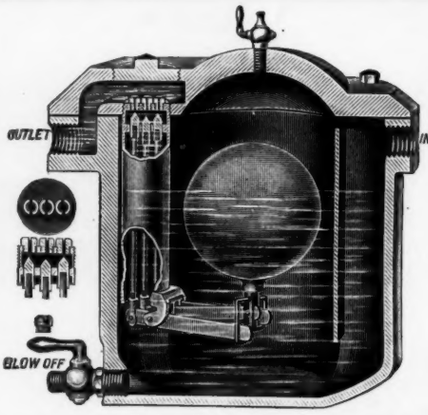
Trill Indicator Co., Corry, Pa.

Please send me a Gold Bond Certificate and full details regarding Trill Triumph Indicators, and your selling plan.

Name . . . . . .

Address . . . . . .

. . . . . .



It's the THREE VALVES in this trap that provide its reputation as a "big capacity" trap.

WRIGHT "EMERGENCY"

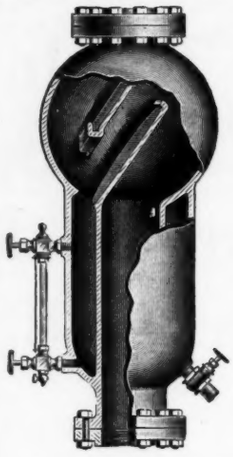
HIGH PRESSURE CONTINUAL FLOW

STEAM TRAP

automatically drains the accumulating condensation from steam systems regardless of small or large quantity and without steam waste.

Ask for catalog C-50. We ship on trial.

WRIGHT MANUFACTURING CO.,
DETROIT, MICH. 127 WOODBRIDGE ST.



Here's one of our most popular types of receiver separators. Its design is symmetrical, the efficiency is a matter of record and the great storage capacity for both live steam and separated water is immense.
What's the diameter of your vertical steam line? Write us.

Austin Fig. "M"

Vertical Receiver

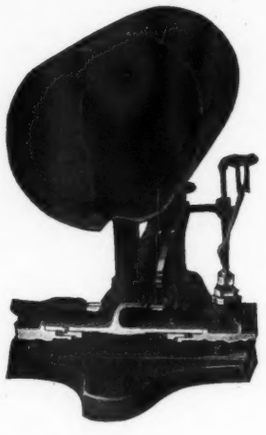
Steam Separator

fully described with many others in our practical Catalog 16-B. Write for it.

We ship on trial.

Austin Separator Company,
Detroit, Mich. 157 Woodbridge St.

Double Service From A Steam Trap



Draining your steam lines and returning the water of condensation to your boilers. This is a bare statement of the purpose of the Morehead Return Steam Trap. But back of this bare statement is a great deal that should not be overlooked by the engineer who is striving for higher efficiency in his plant.

The Morehead Return Steam Trap

For in draining steam lines, the Morehead way is the *perfect* way. There is no danger of a Morehead Trap failing or not getting rid of *all* the condensation and in returning this condensation to the boiler it must be remembered it returns it much hotter and at far less expense than a steam pump could.

Our "Trap Book" which describes Morehead Traps in detail will tell you all about it. Just mention that you want a copy. And we'll forward it immediately.

Morehead Mfg. Company
Dept. "E"
Detroit, Mich.